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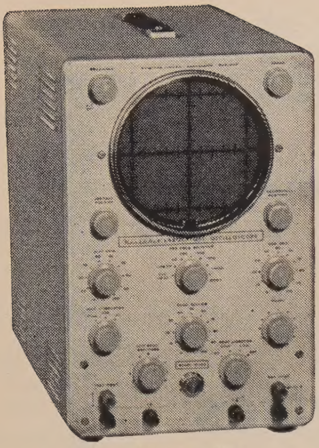

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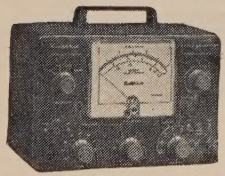

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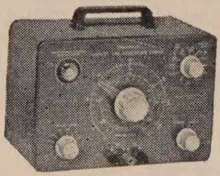

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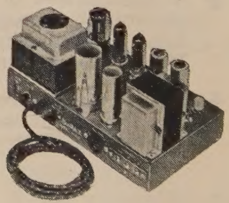

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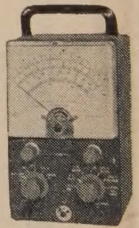

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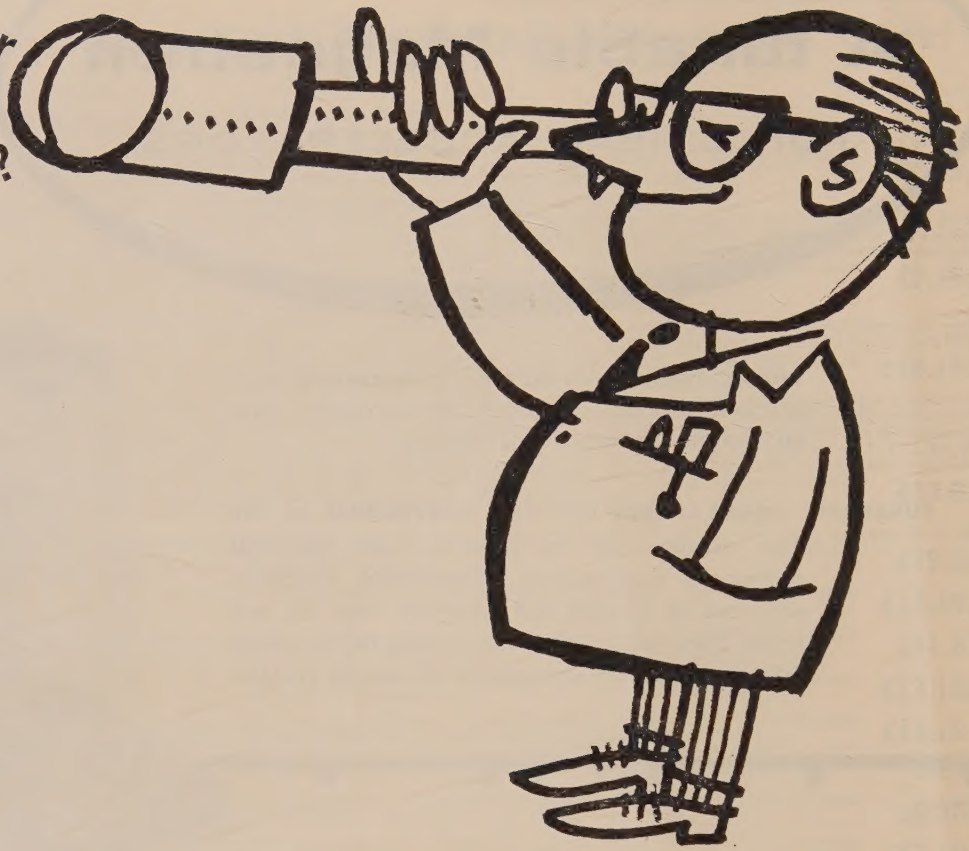
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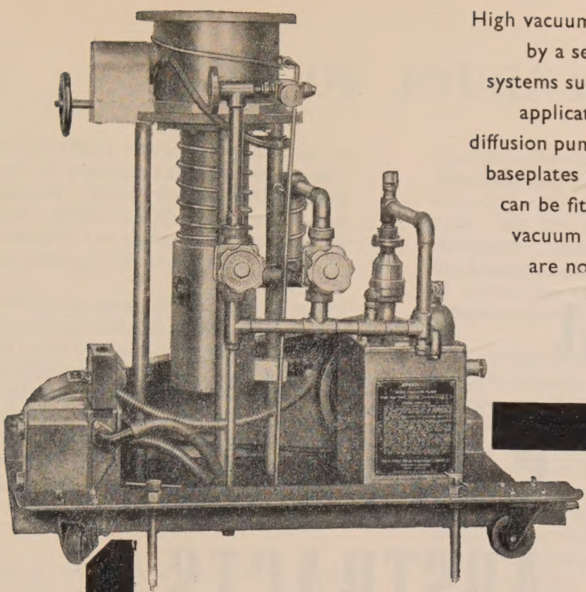

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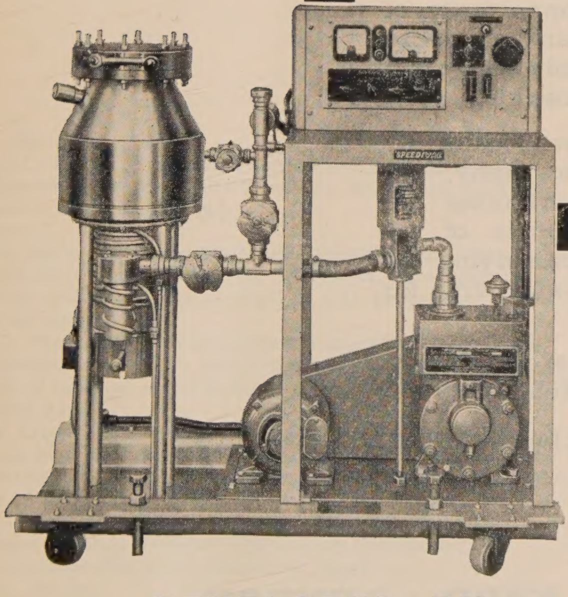

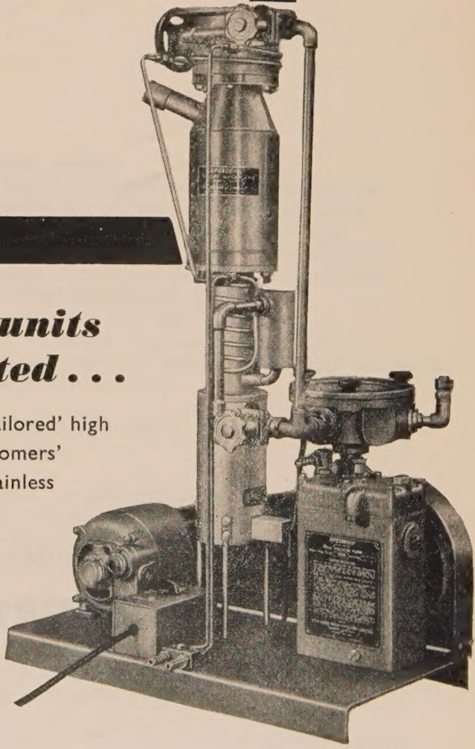

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  - A.C.E.C. Revue. — Ateliers de Constructions Electriques de Charleroi, Avenue Emile Rousseau, Marcinelle-Charleroi. [French - language edition].
- A.E.G. Mitt.
  - A.E.G. Mitteilungen. — Allgemeine Elektricitäts-Gesellschaft, Hohenzollerndamm 150, Berlin-Grunewald. [A translation of selected articles is published as: A.E.G. Progress].
- A.E.G. Progress
  - A.E.G. Progress. — Allgemeine Elektricitäts-Gesellschaft, Hohenzollerndamm 150, Berlin-Grunewald. [English translations of selected articles from: A.E.G. Mitteilungen].
- A.E.I. Engng Rev.
  - A.E.I. Engineering Review. (Replaces: B.T.H. Activities, Metropolitan-Vickers Gazette, Siemens Edison Swan Journal) — Associated Electrical Industries, 33 Grosvenor Place, S.W.1.
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- A.S.T.M. Bull.
  - American Society for Testing Materials. Bulletin. — 1916 Race Street, Philadelphia, Pa.
- A.T.E.J.
  - A.T.E. Journal. — Automatic Telephone and Electric Co., Strowger Works, Liverpool 7.
- A.W.A. tech. Rev.
  - A.W.A. Technical Review. — Amalgamated Wireless Australasia, 554 Parramatta Road, Ashfield, New South Wales.
- Abhandl. Braunschw. Wiss. Gesell.
  - Abhandlungen der Braunschweigischen Wissenschaftlichen Gesellschaft. — Publisher: Friedr. Vieweg, Brunswick.
- Abhandl. Dtsch. Akad. Wiss. Berlin, Kl. Math. Phys. Tech.
  - Abhandlungen der Deutschen Akademie der Wissenschaften, Klasse für Mathematik, Physik und Technik. — Publisher: Akademie-Verlag, Mohrenstrasse 39, Berlin W.8.
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LIST OF JOURNALS

Acta phys. Polon.

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  Zhurnal Éksperimentalnoĭ i Teoreticheskoĭ Fiziki. — Akademiya Nauk SSSR, Lenin Prospekt, Moscow. [A translation is published as Soviet Physics — JETP].
Zh. tekh. Fiz.
  Zhurnal Tekhnicheskoi Fizikĭ. — Akademiya Nauk SSSR, Lenin Prospekt, Moscow. [A translation is published as Soviet Physics.— Technical Physics].

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Central Electricity Generating Board Digest
  Bankside House, Sumner Street, London, S.E.1.

Electrical Research Association
  British Electrical and Allied Industries Research Association, Cleeve Road, Leatherhead, Surrey.

Inst. Internat. du Froid
  Bulletin de l'Institut International du Froid. — 177 Boulevard Malesherbes, Paris 17.

Instrument Abstracts
  Instrument Abstracts. (Formerly: Bulletin of the British Scientific Instrument Research Association). — Compiled by the British Scientific Instrument Research Association (SIRA) and published by Taylor and Francis, Red Lion Court, Fleet Street, London, E.C.4.

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  American Mathematical Society, 190 Hope Street, Providence 6, Rhode Island.

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  Institute of Metals, 17 Belgrave Square, London, S.W.1.

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  American Meteorological Society, 45 Beacon Street, Boston 8, Massachusetts.

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  Metropolitan-Vickers Technical News Bulletin. — Title changed to: Associated Electrical Industries (Manchester) Limited, Research Department Technical News Bulletin [Signature: Associated Electrical Industries (Manchester)].

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  U.S. Atomic Energy Commission Office of Technical Information, P.O. Box 62, Oak Ridge, Tennessee. Obtainable from: U.S. Government Printing Office, Washington 25, D.C.

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  Royal Photographic Society of Great Britain, 16 Princes Gate, London, S.W.7.

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  Science Abstracts of China (Sections: Mathematical and Physical Sciences; Chemistry and Chemical Technology; Biological Sciences; Earth Sciences; and Technical Sciences). — The Institute of Scientific and Technical Information of China, 117 Chao Yang Men Street, Peking.

Scientific Instrument Research Association
  Bulletin of the British Scientific Instrument Research Association. — Title changed to: Instrument Abstracts.

PHYSICS ABSTRACTS

olume 64 JANUARY 1961 Number 757

One year ago, in this place, we asked readers to comment on the value to them of the Universal Decimal Classification numbers printed with each abstract, and this request was repeated at intervals during the year. Only a handful of comments were received, and of these virtually none were favourable to the UDC. It is evident, therefore, that the provision of these numbers serves no significantly useful purpose, and they have now been discontinued.

The arrangement of "chapters" in the present volume is the same as that used last year, except that the total number has been increased by providing new headings and subheadings to divide up some of the longer chapters. There are 123 headings in all, and a list of them, with page references, is given inside the front cover of each issue, to enable any desired subject field to be quickly located.

Though the arrangement of chapters will remain virtually unchanged throughout the current volume, consideration is being continuously given to the possibility of subdivision of long chapters by new subheadings, and to the introduction of new chapters, or even rearrangement of chapters, in response to new developments and investigations. In this connection we earnestly request readers to give advice and suggestions on the basis of their own needs and experience.

MATHEMATICS

1 VARIATIONAL PRINCIPLE FOR COMPATIBILITY EQUATIONS. H.Zorski.
ull. Acad. Polon. Sci. Ser. Sci. tech. (Poland), Vol. 7, No. 7-8, 45-6 (1959).

2 CONNECTION FORMULAS FOR W.K.B. SOLUTIONS WITH TWO TURNING POINTS. H.Moriguchi.
. Phys. Soc. Japan, Vol. 14, No. 7, 968 (July, 1959).

Derives the connection formulae for the WKB solutions of the ifferential equation

$$\frac{d^2y}{dx^2} + f(x)y = 0,$$

here f(x) is a smooth function of x, zero at $x = a$ and $x = -a$, and r $b < x < c$ can be approximated as $f(x) \sim \frac{1}{4}(a^2 - x^2)$ with $c \gg a$, $\ll -a$. H.Morrison

3 AN IMPROVEMENT OF THE W.K.B. METHOD IN THE PRESENCE OF TURNING POINTS AND THE ASYMPTOTIC SOLUTIONS OF A CLASS OF HILL EQUATIONS.
.Moriguchi.
. Phys. Soc. Japan, Vol. 14, No. 12, 1771-96 (Dec., 1959).

A method of successive approximation, which is essentially a odified form of the WKB method, is developed to express, for large alues of parameter h, the asymptotic solutions of a linear second rder differential equation,

$$\frac{d^2y}{dx^2} - \{\lambda + h\, f(x)\}\, y = 0$$

the region where the zeros of the coefficient of y are present. everal simple cases are treated as examples. It is shown that a lass of Hill equations is included in the category to which this ethod is applicable, and that their uniformly valid asymptotic olutions can be expressed in terms of Mathieu functions. The ocally valid expressions are also given by means of the above ethod.

4 THE W.K.B. METHOD FOR THE DIFFERENTIAL EQUATIONS OF THE FOURTH ORDER.
.Saito and I.Oshida.
. Phys. Soc. Japan, Vol. 14, No. 12, 1816-19 (Dec., 1959).

Some types of differential equations of the fourth order, to which the so-called WKB method can be easily extended are studied and some exemplifying solutions up to the first order of approximation are presented. As a physical example, the equation of lateral bending vibration of an incompletely flexible string, whose cross-section of finite size is slowly varying along its length, and whose ends are both clamped, is solved. It is also shown that the terms of the first and the third differentation of a linear differential equation of the fourth order can be eliminated by a suitable transformation.

5 MATHEMATICAL TABLES. VOLUME 4. TABLES OF WEBER PARABOLIC CYLINDER FUNCTIONS AND OTHER FUNCTIONS FOR LARGE ARGUMENTS.
L.Fox.
London: Her Majesty's Stationery Office (1960).

This volume provides tables of a number of common mathematical functions in ranges for which the existing treatment is incomplete or inadequate. The functions tabulated arise in a wide variety of problems in physics, engineering and mathematics. The main table gives the Weber functions W(a, ±x), which occur in the solution of the two-dimensional wave equation in parabolic coordinates, in the range $x \geq +10$, $-10 \leq a \leq +10$ to an accuracy of 8 significant figures. In addition, the exponential integral, sine and cosine integrals, Airy integrals, the error integral and the first six factorial functions are tabulated to 10 significant figures for large values of the argument x. Full interpolation facilities are provided.

6 THE CHARACTERISTIC-FUNCTIONAL METHOD IN CASCADE THEORY. J.W.Gardner.
Nuovo Cimento (Italy), Vol. 17, No. 2, 205-18 (July 16, 1960).

In a previous paper (Abstr. 15309 of 1960) the last-collision equation treatment of the general Markoff cascade was developed and applied to examples drawn from cosmic radiation and nuclear reactor theory. The present paper gives an alternative approach via the characteristic functional, the latter being introduced as a logical extension of the concept of a moment-generating function. Potentially the C.F. embodies complete information about all the probability relations of the stochastic process in question; in practice the extraction of information about any particular distribution depends on a suitable choice of the arbitrary auxiliary function occurring in the definition of the C.F. The power and versatility of the method are illustrated by reference to both point-source and extended-source cascades; it is particularly suited to the treatment of cascades from line sources, examples of which would be, in descending order of energy: a high energy nuclear "jet"; the track of an ionizing particle; the source representation in the Feinberg—Galanin method of nuclear reactor theory.

ASTROPHYSICS

7 THE LARGE TELESCOPE OF THE C.N.R.S., GENERAL DESCRIPTION. A.Couder.

Ann. Astrophys.(France), Vol. 23, No. 3, 311-19 (1960). In French.

"Galactic and extragalactic research" Conference (see Abstr. 18832 of 1960). Description of the 193 cm telescope which the C.N.R.S. has installed at the Observatory of Haute-Provence: general layout; mounting; building and dome; the air flow system.

8 A "TELESCOPE" FOR SOFT X-RAY ASTRONOMY. R.Giacconi and B.Rossi.

J. geophys. Res. (USA), Vol. 65, No. 2, 773-5 (Feb., 1960).

Considerations are given to the design of an X-ray telescope suitable for use in satellites. The use of paraboloidal mirrors is suggested, in which total reflection of the X-rays at near-grazing incidence will give maximum area of collection in the focal plane of the system. G.M.Brown

9 THE FLEXURE OF THE HORIZONTAL AXIS OF A TRANSIT INSTRUMENT. L.Roze.

Latv. PSR Zinat. Akad. Vestis (USSR), No. 8 (157), 53-8 (1960). In Russian.

10 A CAMERA FOR THE OBSERVATION OF THE MOON WITH THE NORMAL ASTROGRAPH AT THE MAIN ASTRONOMICAL OBSERVATORY OF THE ACADEMY OF SCIENCES, USSR IN PULKOVO. H.I.Potter and Y.S.Streletskii.

Astron. Zh. (USSR), Vol. 36, No. 6, 1047-52 (1959). In Russian. English translation in: Soviet Astron.—AJ (USA), Vol. 3, No. 6, 960-4 (May-June, 1960).

The camera uses the Markowitz method for stopping the moon's motion by rotating a plane parallel dark filter near the focal plane during the exposure period. The theory of the method is given and used to determine the optimum filter thickness for an exposure in the range $\frac{1}{2}$-2 minutes. The rotation is non-uniform and this is achieved by using an a.c. driving motor with variable frequency power supply. Practical details of the equipment are given. R.W.Fish

11 EVOLUTION IN GENERAL RELATIVITY. W.Israel.

Nuovo Cimento (Italy), Vol. 18, No. 2, 397-9 (Oct. 16, 1960).

It is shown that "no matter-filled cosmological model satisfying $0 < p < \frac{1}{3}\rho$ can evolve from a flat space-time". Indeterminacy in the evolution of cosmological models is discussed briefly in terms of an equation of state [compare Bonnor, Journal of Mathematics and Mechanics (USA), Vol. 9, 441 (1960)]. F.A.E.Pirani

12 SIGNIFICANCE OF THE MACH PRINCIPLE. P.W.Bridgman.

Amer. J. Phys., Vol. 29, No. 1, 32-6 (Jan., 1961).

It is shown that the fact that a local Galilean frame of reference or a local instrument such as the gyrocompass preserves its orientation with respect to the universe of stars is adequately explained by the fact that the universe of stars has the unique property of having no detectable mechanical interaction with local bodies. The Mach principle asserts that the universe of stars has some connection with local mechanical phenomena. The considerations of this note suggest that the universe of stars appears to have some connection with local phenomena for the paradoxical reason that it has no connection.

13 ON ION CLUSTERS IN THE INTERSTELLAR GAS. B.Donn.

Astrophys. J. (USA), Vol. 132, No. 2, 507-9 (Sept., 1960).

A theoretical examination of the suggestion made by Krassovsky (1958) that clusters of large numbers of atoms and molecules should form around interstellar ions. It is concluded that even ion-molecule pairs are essentially nonexistent in space. D.R.Barber

14 THE ORIGIN OF THE SOLAR SYSTEM. W.H.McCrea.

Proc. Roy. Soc.(GB) A, Vol. 256, 245-66 (June 21, 1960).

The theory outlined attempts to relate the problem of the origi of the solar system to the general problem of star formation. Reasons are given for concluding that interstellar material in whic stars are about to be formed consists of fragments ("floccules") moving at random amongst themselves and probably composed mainly of molecular hydrogen, the temperature being about 50° K and the random velocities about 1 km/sec. Many stars would then be formed simultaneously, each by the aggregation of portions of material that happen to be moving together. The process producin condensations that grow into stars would also produce minor condensations in material that becomes trapped in the growing gravitational fields of these stars, i.e. planetary systems associated with the stars. It appears to be consistent with this general picture to suppose that the solar system was formed in a region whose radius was about the initial mean free path of the "floccules", and that it accounts for the amount of material originally within this region an for the amount of angular momentum originally possessed by the material in consequence of its random motions. The hypothesis is made that the mass, size and number-density of "floccules" are su that in this way the total mass, radius and angular momentum of the actual solar system are reproduced, thus leaving no free parameters. The particular region considered is centred upon that particular incipient condensation that is destined to grow into the sun. The process of growth is considered and it is shown that, on account of the randomness in the directions from which the materi arrives, the resulting sun would have about the right angular mome tum. Therefore there would remain in the region a certain amoun of material moving at first in randomly disposed orbits about this sun and still carrying most of the original angular momentum. Thi system would flatten out towards its invariable plane; in order to retain the angular momentum, its final mass must be about that of the actual planetary system. The production of condensations in th material yields a number of these each not greatly in excess of the critical mass for gravitational contraction. This is found to be about the average mass of the actual planets and so this, and about the right number of planets, is accounted for. The Roche limit for the estimated initial density of the planets so formed is at about Jupiter's orbit; thus the theory requires a differentiation between planets formed outside and inside this distance. It also suggests that when the planets were first formed the sun's tidal action was for a time sufficient to keep them revolving with "the same face" towards the sun; conservation of angular momentum during subsequent gravitational contraction would ultimately require faster axial rotation. It is shown that this may account for the direct axial rotations of the actual planets. The times for the various stages are roughly estimated and it appears that the duration of the entire process would be some 2×10^5 years. Finally, it is pointed out that, if the theory be taken in the first place as no more than suggestive, it would suffice strongly to indicate that the sun's actua angular momentum is most simply accounted for by supposing it to have been produced by the assembling of portions of material of about the mass considered, while the planets' actual masses are most simply accounted for by supposing them to have been produce from portions of about the density considered. Thus not only would the quantitative hypotheses be checked, but the essentials of the theory would be recovered.

15 RESULTS OF THE OCCULTATION OF REGULUS BY VENUS, JULY 7, 1959.

G. de Vaucouleurs and D.H.Menzel.

Nature (GB), Vol. 188, 28-33 (Oct. 1, 1960).

A detailed discussion of the results obtained from visual, phot graphic, and photoelectric observations of ingress and egress of th star made by teams of observers from Harvard College Observato and the Smithsonian Astrophysical Observatory, U.S.A. The obser imes of ingress, and egress at half-intensity are tabulated for 24 ocations in Europe, Asia, and Africa. A model of the Venusian tmosphere, based on microwave, radiometric, spectroscopic and ccultation data, is described. D.R.Barber

16

SOUTHERN HEMISPHERE METEOR SHOWER ACTIVITY IN JULY AND AUGUST. A.A.Weiss.

Austral. J. Phys., Vol. 13, No. 3, 522-31 (Sept., 1960).

Gives observations of the radiant positions and the activities of the δ-Aquarids and three minor showers of July and August, obtained with high-resolution radio equipment at Adelaide from 1957 to 1959. Data for the δ-Aquarids were combined with similar observations in 1953 to obtain the radiant ephemeris $\alpha = 342.3^\circ + 0.76\ (\odot - 126.0^\circ)$, $\delta = -16.4^\circ + 0.13\ (\odot - 126.0^\circ)$. The δ-Aquarid activity extended from July 20 to August 14, with a maximum near July 29. Minor shower activity, extending over and beyond the whole duration of δ-Aquarid activity, was identified as proceeding from three main centres already known visually: the Capricornids, the Pisces Australids, and Cetids.

17

METEOR HEIGHT DISTRIBUTIONS AND THE FRAGMENTATION HYPOTHESIS. A.A.Weiss.

Austral. J. Phys., Vol. 13, No. 3, 532-49 (Sept., 1960).

This paper is concerned with a comparative study of the incidence of fragmentation amongst bright and faint meteors, as disclosed by photographic measurements of heights and light curves of brighter meteors (visual magnitudes $< +4$), and by measured radio-echo height distributions of faint meteors (visual magnitudes $\sim +6$). The discussion is based on photometric and height data for sporadic and shower meteors obtained by Harvard and Canadian observers, and on radio-echo height distributions measured at Jodrell Bank. Mean photographic light curves were shorter than predicted by evaporation theory, and there was a large residual scatter in the heights of maximum brightness after reduction to standard meteor velocity and brightness. Trail length was independent of reduced height, and also of velocity if this exceeded 25 km/sec; for slower meteors trail lengths shortened rapidly. The radio-echo height distribution as a function of trail length was calculated for a simple model which incorporated these features of the ablation process for brighter meteors. Comparison with radio height measurements indicates that meteors below the photographic threshold showed a closer approach to the predictions of the evaporation theory than meteros bright enough to record photographically.

18

LEAD AND ITS ISOTOPIC COMPOSITION IN IRON METEORITES.

I.E.Starik, E.V.Sobotovich, G.P.Lovtsyus, M.M.Shats and A.V.Lovtsyus.

Dokl.Akad. Nauk SSSR, Vol. 134, No. 3, 555-8 (Sept. 21, 1960). In Russian.

The results of an analysis of the lead contents of 12 meteorites are given. There are two distinct groups; the members of one, all octahedrites, have primary isotopic compositions; those of the other, of various forms, have ordinary terrestrial compositions. The variation of lead contents in different zones and forms of the same meteorite is investigated, as is also the composition of troilite inclusions. G.A.Chisnall

19

PHYSICAL OBSERVATIONS OF THE PERIODIC COMET GIACOBINI—ZINNER (1959 b).

P.Mianes, S.Grudzińska and A.Stawikowski.

Ann. Astrophys. (France), Vol. 23, No. 5, 788-96 (1960). In French.

The magnitude of the comet Giacobini—Zinner (1959b) was measured photoelectrically in two spectral regions, one of them centred around the (0-0) band of CN. The radius of the nucleus was estimated as ~1 km. The photoelectric magnitudes of 1959b and 1957c have been used to estimate the abundances of the CN- and C_2 radicals and of solid particles in the heads.

COMET WHIPPLE—FEDTKE—TEVZADZE 1943 I (1942 g). STUDY OF CN BAND SPECTRUM. See Abstr. 20611 of 1960.

20

THE ABUNDANCE OF CO⁺ IONS IN COMETARY TAILS. S.Grudzińska.

Ann. Astrophys. (France), Vol. 23, No. 5, 797-801 (1960). In French.

The comparison of the intensities of the (2-0) band of CO^+ (in the tail) and of the(0-1) band of CN (in the head) of comet Bester (1947k) gives the relative abundances of CO^+ and CN at various distances from the nucleus. It is found that the abundance of CO^+ in the tail is greater than that of CN in the head by a factor of 30 to 40, at nucleocentric distances less than 130 000 km. Assuming an abundance of CN equal to that suggested by Wurm for C_2 it is found that the tail contains 10^6 CO^+ ions per cm^3 in the neighborhood of the head.

CATALOGUE OF DISTURBANCES IN IONOSPHERE, GEOMAGNETIC FIELD, FIELD INTENSITY OF RADIO WAVE, COSMIC RAY, SOLAR PHENOMENA AND OTHER RELATED PHENOMENA. See Abstr. 21343 of 1960.

21

THE STRUCTURE OF THE SUN.

A.G.Masevich and T.G.Volkonskaya.

Astron. Zh. (USSR), Vol. 37, No. 1, 42-50 (Jan.-Feb., 1960). In Russian. English translation in: Soviet Astron. —AJ (USA), Vol. 4, No. 1, 40-8 (July-Aug., 1960).

A new model of the solar interior consists of three parts differing in chemical composition: (1) an outer shell without energy sources whose chemical composition is indicative of the initial composition of the entire sun; (2) an intermediate zone in which energy is released by proton—proton reactions, and for which generation by carbon—nitrogen reaction is negligible; (3) a central nucleus where the energy yield in controlled by both p—p, and C—N reactions. Thus the main source of energy is the p—p reaction, the Bethe cycle being a minor one even in the central nucleus. The present model bears a physical resemblance to that of Epstein and Motz (1953). Comparative data for 15 different solar models, proposed between 1947 and 1958, are tabulated. D.R.Barber

22

ON THE POSSIBLE EXISTENCE OF A POLARISATION EFFECT CONNECTED WITH THE CENTER-LIMB EFFECT IN THE SOLAR SPECTRUM. M.Rudkjøbing.

Ann. Astrophys. (France), Vol. 23, No. 5, 802-3 (1960).

A certain general type of perturbation of the atoms in the solar atmosphere might produce line shifts depending in magnitude on the state of linear polarization of the emitted light and on the position on the solar disk. Observational evidence as to the existence or non-existence of such an effect might elucidate the problem as to the degree to which Doppler shifts are responsible for the centre-limb effect.

23

A HYDROMAGNETIC DISCUSSION OF THE MERIDIONAL DRIFT OF THE SUNSPOTS. I.K.Csada.

Acta phys. Hungar., Vol. 11, No. 4, 317-22 (1960).

The meridional drift of the sunspots studied statistically by Tuominen is discussed here by means of a hydromagnetic model. The earlier assumptions concerning the structure of the solar magnetic field are used and the motions of the hydromagnetic waves along the lines of force of a superposed dipole and octupole considered. A value of h = 0.3 is found for the ratio of the moment of the octupole to that of the dipole field, which is in good agreement with the previous results. Furthermore, certain heliographic latitudes ($B = \pm 16^\circ$) are found which divide motions towards the equator and towards the poles; thus a theoretical explanation of Tuominen's results is possible.

STATISTICAL EFFECTS DUE TO THE CONNECTION BETWEEN FLOCCULI AND GEOMAGNETIC DISTURBANCES. See Abstr. 21315 of 1960.

SOLAR DISTURBANCES AND THE COSMIC RAY EQUATOR. See Abstr. 20276 of 1960.

24

OBSERVATIONS OF THE SOLAR CHROMOSPHERE DURING 1957. M.Hotinli.

Rev. Fac. Sci. Univ. Istanbul C(Turkey), Vol. 24, No. 3-4, 166-205 (July-Oct., 1959). In French.

During 1957, at the Istanbul Observatory, the chromosphere was observed for a total of 246 hr 54 min distributed over 245 days. Seven hundred and sixty nine photographs were taken and 469 flares observed, 220 of which were on the northern hemisphere and 249 on the southern hemisphere. The distribution with respect to the central meridian is as follows: 235 flares on the western hemisphere, 229 on the eastern hemisphere, and 5 on the central meridian. The frequencies and the mean duration of flares of different classes are given, together with the time of visual and photographic observations, the characteristic numbers of the filaments, the commencement and ending of the flares, and their importance and coordinates. Whenever possible, the time of maximum intensity is also noted.

25 HYDROMAGNETIC MODEL FOR A QUIESCENT PROMINENCE.

P.L.Bhatnaga and B.B.Chakraborty.
Proc. Nat. Inst. Sci. India A, Vol. 25, No. 6, 380-7 (Nov., 1959).

A two-dimensional model is proposed in which the material, treated as a compressible fluid of infinite electrical conductivity, is in hydrostatic equilibrium under gravity, pressure gradient and Lorentz force. The previous models proposed by Menzel, Dungey and Kippenhahn and Schluter are examined for the postulated magnetic fields and volume currents in them and the difficulty in their realization is pointed out. In the proposed model the field distribution may perhaps be realized from a magnetic field associated with a bipolar sunspot zone idealized for the sake of simplicity to be a line dipole, by the motion of the chromospheric material forming the prominence which carries the lines of force along with it due to high electrical conductivity.

26 ON THE APPEARANCE OF COSMIC RAYS IN THE "PINCH EFFECT" IN SOLAR FLARES.

A.B.Severnȳi.
Astron. Zh. (USSR), Vol. 36, No. 5, 972 (1959). In Russian. English translation in: Soviet Astron.-AJ (USA), Vol. 3, No. 5, 887 (March-April, 1960).

The "pinch effect" in the discharge channel of a solar flare will cause two magnetohydrodynamic shock waves to advance toward each other, and ultimately to collide. As a result, the gas stream is heated to $\sim 1.5 \times 10^{7}$ °K, and by repeated reflections at the advancing wavefronts (which act as "magnetic mirrors") the plasma particles acquire energies of 10^{9}-10^{10} eV. This mechanism will yield a cosmic-ray flux of ~ 1 particle cm^{-2} sec^{-1} at the earth's surface, in agreement with observation. D.R.Barber

COSMIC RAYS FROM THE SUN. See Abstr. 20277 of 1960.

SOLAR FLARE CONNECTED WITH AN INCREASE OF INTENSITY OF COSMIC RAYS. See Abstr. 20275 of 1960.

27 INFRARED SOLAR SPECTROSCOPY AT THE JUNGFRAUJOCH (SWITZERLAND).

L.Delbouille and M.Migeotte.
J. Opt. Soc. Amer., Vol. 50, No. 12, 1305-7 (Dec., 1960).

The solar spectrum has been recorded, under high resolving power, between 7500 A and 12 000 A at the International Scientific Station of the Jungfraujoch (elevation: 3580 m). A solar atlas covering the mentioned spectral region is now in preparation.

28 STUDY OF THE SPECTRA TAKEN BY BERNARD LYOT OF THE ECLIPSE AT KHARTOUM OF 28 FEBRUARY 1952. II. STUDY OF A CORONAL CONDENSATION.

C.Pecker.
Ann. Astrophys. (France), Vol. 23, No. 5, 764-87 (1960). In French.

Interpretation of the equivalent widths measured along a coronal condensation on the spectra of the Khartoum eclipse (1952). The inaccuracy of the physical data (ionisation cross-sections, excitation cross-sections by electronic collisions) makes a conclusion difficult.

H.F. PROPAGATION DURING THE ECLIPSE OF 19 APRIL 1958. See Abstr. 19940 of 1960.

29 CONSIDERATIONS BEARING ON THE STRUCTURE OF THE GALAXY.

L.Biermann and L.Davis, Jr.
Z. Astrophys. (Germany), Vol. 51, No. 1, 19-31 (1960).

A re-examination is made of several considerations bearing on the structure of the galactic halo regarded as the region of storage of relativistic electrons and cosmic rays; their interrelations yield new restrictions on the possible range of galactic models. First, the number of relativistic electrons required to produce the non-thermal radio emission of the halo by synchrotron radiation should be compatible with the measurements of Critchfield et al. (Abstr. 2809 of 1952) on the upper limit of the flux of relativistic electrons at the earth, provided the latter is increased by a factor of about 3 to allow for the effect of solar activity. This requires that the magnetic field in the halo be $\gtrsim 5 \times 10^{-6}$ G and that in the disk $\gtrsim 2 \times 10^{-5}$ G, larger values being required if the electron flux is actually less than the upper limit. These lower limits are somewhat larger than the values usually quoted, but are not inconsistent with actual observational evidence. Secondly, if the gas, magnetic fields, and cosmic radiation of the Galaxy are in an essentially steady state, the virial theorem may be applied to them. The magnetic fields, cosmic rays, thermal pressure, and kinetic energy of the gas all contribute positive terms which must be balanced by a negative term due to gravity. The main alternatives allowed appear to be: (1) A model with magnetic fields as discussed above, gravitational energy of the halo gas negligible, velocity of rotation of the gas in the disk less than the circular velocity determined by gravity alone by about 15 km/sec. (2) A model with a gas density in the halo $\cong 10^{-2}$ particle cm^{-3} (as proposed by Pickelner and Shklovsky), this gas being supported mainly by hydromagnetic waves, not by kinetic energy of mass motion or thermal pressure. In this case no lag in circular velocity of gas in the disk is required; and a wide range of halo volumes is possible. There is no problem with radio emission (if halo volume $\cong 2400$ kpc^{3}, the halo field is about 5×10^{-6} G). A decision whether either of these alternatives is possible will require more detailed dynamical analyses and further observational data.

30 ON THE PROBLEM OF THE NATURE OF THE GAS CORONA OF THE GALAXY.

S.B.Pickelner and I.S.Shklovsky.
Ann. Astrophys. (France), Vol. 22, No. 6, 913-25 (1959).

A review and critical discussion of the optical and radio data relevant to the problem of the spheroidal galactic halo-system. Static and dynamic models are examined and compared; particularly in relation to the role played by cosmic rays in causing the ejection of rarefied gas streams ($N < 10^{-2}$ cm^{-3}) by stars and in supplying the necessary additional energy to maintain the motions of relativistic electrons, and gas within the halo. The very large dimensions of the galactic halo, when compared with the main stellar system, appear to result from the cosmic-ray pressure decreasing more slowly with time than the gas density. This leads to instability of the halo, and its systematic expansion. The balance of argument appears to favour a dynamical model of the halo, as opposed to a purely static one. D.R.Barber

31 A NEW LIMIT TO THE GALACTIC FIELD SET BY MEASUREMENTS OF THE ZEEMAN SPLITTING OF THE HYDROGEN LINE.

R.D.Davies, C.H.Slater, W.L.H.Shuter and P.A.T.Wild.
Nature (GB), Vol. 187, 1088-9 (Sept. 24, 1960).

The limit to the magnetic field set by measurements on three lines in the Cassiopeia A absorption spectrum is 10^{-5} oersted for the Perseus arm of the Galaxy and 0.5×10^{-5} oersted for the Orion arm. Measurements on Taurus A give a limit of 2×10^{-5} oersted for the Orion arm while measurements on Sagittarius A show a radial component of magnetic field less than 5×10^{-5} oersted. The upper limit to the magnetic field set by this experiment is significantly smaller than required by some theories, which may now have to be reconsidered. C.Hazard

32 THE EVOLUTION OF GALACTIC CLUSTERS.

G.Maurikakis.
Tech. Chron. (Greece), Vol. 37, 51-62 (Jan.-Feb., 1960).

In a first part, the escape of stars from an isloated galactic cluster is discussed and the following determined:the mean time of relaxation, the number of the escaping stars during this time, and the rate of escape. The dynamical evolution of the cluster is discussed and it is concluded that the cluster is continuously contracted by the escape of its stars, and will finally become a stable star. The course of the evolution is considered and it is concluded that the galactic cluster will first lose the stars with a mass less than the average mean mass, which are at some distance from the centre of the cluster, then the stars with the mean mass and finally the stars with a mass of greater than the mean. In the second part the course of evolution of a galactic cluster is discussed by taking, separately: (a) the change of the energy, H, of the cluster because of encounters with intergalactic clouds and the escape of its stars; (b) the change of the energy of the cluster due to encounters with isolated stars of the Galaxy and the escape of its stars; and (c) the change of the energy of the cluster due to encounters with intergalactic clouds and isolated stars, and the escape of its stars. In cases (a) and (b), the critical radius Ro, and the radius, R, of the cluster at every moment,as well as the life time of the cluster can be found.

33 COMMENTS ON SOME PHYSICAL PROCESSES IN DIFFUSE NEBULAE.

S.R.Pottasch.
Ann. Astrophys. (France), Vol. 23, No. 5, 749-63 (1960).

It is shown that the two quantum transition from the 2s level of hydrogen is the predominant source of visible continuous emission i diffuse nebulae. From the measures of the continuum intensity in diffuse nebulae by Shajn, Hase and Pikelner, it is possible to deduce the population of the 2s level and the electron density in many diffuse nebulae. The electron density thus found is the same as that deduce from the assumption that the size of a diffuse nebula is limited by the amount of ionizing radiation emitted within it. The population of the second level of hydrogen is found and the total optical depth in he centre of Hα in diffuse nebulae is shown to be of the order of nity. The amount of ionizing radiation emitted by the exciting star s found by a variation of the method first used by Zanstra. The ransfer of Lyman α radiation is discussed.

34
THE ORIGIN OF COMETARY NEBULAE.
É.A.Dibai.

Astron. Zh. (USSR), Vol. 37, No. 1, 16-22 (1960). In Russian. English translation in: Soviet Astron. - AJ (USA), Vol. 4, No. 1, 13-18 (July - Aug., 1960).

The following mechanism is proposed: An ionized front moving in neutral gas is retarded by density fluctuations forming dark trunks with vertices pointing toward the exciting star. The trunk retards the ionization front and is subject to compression; this leads to the formation of a star at the vertex, and the developing star illuminates the dark trunk and converts it into a bright cometary nebula. R.A.Newing

35
SIX-COLOR PHOTOMETRY OF TEN CLASSICAL CEPHEIDS.
S.N.Svolopoulos.

Astron. J. (USA), Vol. 65, No. 8, 473-80 (Oct., 1960).

Six-colour observations of the cepheids U Aql, FF Aql, SU Cas, X Cyg, SU Cyg, DT Cyg, Y Oph, S Sge, Y Sgr, and T Vul, made with the 22 in. Tauchmann reflector, are presented. Light and colour variations were determined in each of the six colours. Values of the phase retardation of the various light curves are given. The relation between the light range and the inverse wavelength was found to be linear in all cases, but with deviating points in the colours U, V, and I; the deviations are attributed to absorption in the outer layers of the stars. Eggen's type C cepheids are distinguished from those of types A and B of the same period in having a less steep slope in the relation between light range and inverse wavelength. Temperatures at maximum and minimum light were derived from the six-colour data: the average temperature range was found to be 1550° for type A and B cepheids and 750° for type C cepheids. Mean radii are given for four cepheids having accurate radial-velocity curves.

36
STELLAR INFRARED PHOTOMETRIC STUDIES BY MEANS OF A LEAD SULPHIDE PHOTOCELL.
M.Lunel.

Ann. Astrophys. (France), Vol. 23, No. 1, 1-61 (1960). In French.

A PbS photocell used for the study of bright stars from different spectral classes. The output of the cell is amplified by a factor of ~ 3×10^5. Stars were studied through the following filters: Wratten 88, Ilford 207, Schott UG 7, which eliminate the radiations of wavelength shorter than 7200, 7400, 9000 A, respectively; the combination of an alum crystal and a gelatine filter, giving a passband between 1 and 1.4 micron; the combination of a germanium filter and an interferometric filter, with a passband between 1.8 and 2.5 micron. The latter two regions were chosen because they are rather well located between the very strong telluric bands. Values of the optical density at the zenith were found to be much higher than those resulting only from the molecular diffusion. The observed absorption results certainly from the selective absorption of water vapour to which the effect of the fog is added.

37
MODELS OF PURE HYDROGEN STARS.
A.Boury.

Bull. Soc. Roy. Sci. Liege, (Belgium), Vol. 29, No. 11-12, 306-24 (Nov.-Dec., 1960). In French.

Models have been constructed for masses ranging between 20 and 6650 solar masses, although the higher masses are probably unstable from the start. The models consist of a convective core and a radiative envelope, in which the opacity is due to electron scattering. Their characteristics are listed. These models can be adapted also to any other homogeneous chemical composition as long as scattering remains the main source of opacity.

38
EVOLUTION OF MASSIVE STARS. II. HELIUM-BURNING STAGE.
C.Hayashi, J.Jugaku and M.Nishida.

Progr. theor. Phys. (Japan), Vol. 22, No. 4, 531-43 (Oct., 1959).

For Pt I, see Abstr. 14464 of 1960. To investigate the evolution of massive stars in the helium-burning stage, four sample models ($M = 15.6 M_{\odot}$) consisting of the following four regions are constructed: (1) hydrogen-rich envelope, (2) radiative zone with varying hydrogen content, (3) radiative helium region, (4) convective helium core. The results show that these models lie in the Hertzsprung gap of the h and χ Persei cluster and do not explain the existence of the red supergiants branch of this cluster. These models are also compared with those in which the rate of helium burning is slower by a factor of 10. The comparison shows that the properties of models having the double energy-source are very sensitive to the rates of both hydrogen- and helium-burning.

39
INTERNAL STRUCTURE AND EVOLUTION OF VERY MASSIVE STARS.
S.Sakashita and C.Hayashi.

Progr. theor. Phys. (Japan), Vol. 22, No. 6, 830-4 (Dec., 1959).

The internal structure of very massive stars with 46.8 solar masses is investigated in their early stage of evolution. Starting from an initial homogeneous model, their evolution is followed to the stage where the hydrogen in the core diminished to 9% in weight. The inhomogeneous models consist of three regions, a hydrogen-rich envelope, a hydrogen-consuming core, and a semi-convective intermediate zone. In the last zone, the mean molecular weight varies continuously and its distribution is determined by the condition of convective neutrality, where the gradient of mean molecular weight resulting from the convective mixing between the envelope and the core is taken into account. It is shown that the stars stay in the H—R diagram nearly at the same position as the main sequence stars until the hydrogen in the core is mostly exhausted, and their life is about 3×10^6 years.

CREATION OF THE HEAVY ELEMENTS BY NEUTRON CAPTURE ON A FAST TIME SCALE. See Abstr. 20485 of 1960.

40
THE SURFACES OF STARS.
B.E.J.Pagel.

Quart. J. Roy. Astron. Soc. (GB), Vol. 1, No. 1, 56-72 (Sept., 1960).

Starting from the basic conception of an equilibrated system, for which the central gas pressure is sufficient to balance the large gravitational attraction of the stellar mass, it is shown that this condition will initiate nuclear reactions (involving H and He) whereby energy is released from the stellar core. The physical processes concerned with the transfer of this energy to the surface layers of the star (as radiation) are discussed in terms of both thermodynamical and atomic theories. The conditions pertinent to continuous emission, and absorption in actual stellar atmospheres are described. D.R.Barber

Radioastronomy

41
INVESTIGATION OF THE UNIVERSE BY RADIO ASTRONOMY.
A.C.B.Lovell.

Nature (GB), Vol. 188, 13-14 (Oct. 1, 1960).

A summary of a Royal Society Tercentenary Lecture dealing with some of the significant advances made by the application of the new techniques of radioastronomy to the study of the solar system and universe. The discussion ranges from radio-echo studies of meteors to the cosmological issues involved in the study of the isotropically distributed radio sources. C.Hazard

42
THE NEW RADIO ASTRONOMY CENTRE OF THE UNIVERSITY OF SYDNEY.
H.Messel.

Nature (GB), Vol. 188, 528-9 (Nov. 12, 1960).

RELATIONSHIP BETWEEN SOLAR RADIO BURSTS AND COSMIC-RAY AND MAGNETIC STORMS. See Abstr. 20280 of 1960.

43
RADIO DETECTION OF THE PLANET SATURN.
J.J.Cook, L.G.Cross, M.E.Bair and C.B.Arnold.

Nature (GB), Vol. 188, 393-4 (Oct. 29, 1960).

A report of the detection of 3.45 cm radiation from Saturn using an X-band ruby maser radiometer and 85-ft diameter paraboloid. The total equivalent noise temperature of the system is about 100° K. A modified Dicke system was used, one channel comprising a beam directed at Saturn and the comparison channel comprising a beam displaced by about 3.5 beam-widths in declination. The peak antenna temperature observed was about 0.1° K, giving an equivalent black body disc temperature of about 106° K in reasonable agreement with that predicted from optical measurements. C.Hazard

44
RECENT DEVELOPMENTS IN SOLAR RADIO ASTRONOMY.
A.Maxwell.

Proc. Nat. Acad. Sci. USA, Vol. 46, No. 9, 1260-9 (Sept., 1960).

A brief description of some of the observational programmes now in progress in solar radioastronomy and the techniques used in these investigations, followed by a summary of some of the current theories of radioemission from the solar atmosphere. C.Hazard

45 ON THE POLARIZATION OF SOURCES OF SOLAR ACTIVITY ON 3 cm WAVELENGTH.
M.R.Kundu and J.L.Steinberg.
J. Instn Telecomm. Engrs (New Delhi), Vol. 6, No. 1, 23-30 (Dec., 1959).

A discussion of the principle of measurement of polarization by interferometer methods followed by a description of the equipment. The aerial system has a resolution depending on the position of the sun, being a maximum of 1.8' of arc at noon during the equinoxes and having a minimum resolution of the order of 10' of arc. The aerial system provides rejection against the unwanted polarization of more than 40 dB. Dimensions of polarized and unpolarized sources have been measured. For a persistent source the majority of the polarized emission comes from the narrow bright region ($< 1.5'$ of arc). About 60% of bursts are polarized, the probability of observing a polarized burst being greater for those of small diameter. Great bursts associated with metre wave bursts of type IV are usually polarized. C.Hazard

46 ON THE IDENTIFICATION OF EXTRAGALACTIC RADIO SOURCES. B.Y.Mills.
Austral. J. Phys., Vol. 13, No. 3, 550-77 (Sept., 1960).

Identifications of radio sources with galaxies and clusters of galaxies were sought systematically in a limited region of the sky. The optical data were taken principally from the National Geographic Society—Palomar Observatory Sky Atlas and a catalogue of clusters of galaxies prepared by Abell (1958) from the same Atlas. The radio data were taken from results obtained with the Sydney cross-type radio telescope, supplemented at times with additional information from a recent Cambridge Catalogue (3C). A total of 46 possible identifications with galaxies were listed and 55 possible identifications with clusters of galaxies, the great majority of which are new. Most of these galaxies were double systems, but no other common features could be recognized: it seemed probable that many galaxies of completely normal appearance were very strong radio emitters. The possible nature of the double galaxies was discussed briefly and attention was drawn to a corresponding duplicity in the radio brightness distribution observed in some strong radio sources. In many cases the emission from clusters appeared to be associated with a single galaxy or pair of galaxies in the cluster; evidence for the existence of radiation of intergalactic origin is inconclusive. A selection of the possible galaxy identifications was used to derive a provisional radio luminosity function; it appeared probable that there was no distinct class of "radio galaxies", but all radio luminosities appeared to be represented, the numbers of radio sources in a given volume of space falling rapidly with increasing luminosity. A radio luminosity function of the form derived was capable of accounting for a substantial number of the radio sources of small size observed at high galactic latitudes; the remainder could be accommodated by the uncertainty in the data. It was found that, at the levels to which source counts can currently be taken, cosmological effects are likely to be small, although the most distant sources are markedly affected.

47 A RADIOMETER FOR THE HYDROGEN LINE.
B.Höglund and V.Radhakrishnan.
Chalmers Tekn. Högsk. Handl. (Sweden), No. 223, 25 pp. (1959).

Space Research

48 ARTIFICIAL EARTH SATELLITES.
L.G.Jacchia.
Scientia (Italy), Vol. 95, No. 9, 279-86 (Sept., 1960). In English. French transl. in Supplement.

Describes the techniques that are currently employed to track artificial earth satellites: optical and radio observations, their organization and final reduction by high-speed electronic computers. The motion of a satellite in the earth's gravitational field is analysed and it is shown how a study of this motion has led to much improved values for the flattening of the earth and to the discovery of an asymmetry in the earth's shape; other important geodetic results are expected from future satellites. The progressive shortening of the period of satellites caused by atmospheric drag has extended the present knowledge of the upper atmosphere to a height of 700 km and has revealed that the atmosphere has a bulge in the direction of the sun and fluctuates in density under the influence of ultra-short wave and corpuscular radiation.

49 INSTRUMENTS FOR SPACE RESEARCH.
R.L.F.Boyd.
Research (GB), Vol. 13, No. 8, 290-4 (Aug., 1960).

Review for the non-specialist.

"TELESCOPE" FOR SOFT X-RAY ASTRONOMY.
See Abstr. 8

50 PERTURBATIONS OF THE ORBIT OF THE ECHO BALLOON. I.I.Shapiro and H.M.Jones.
Science (USA), Vol. 132, 1484-6 (Nov. 18, 1960).

The motion of the Project Echo communications satellite during its first 12 days clearly confirms previous predictions of the influence of solar radiation pressure. During this time, solar pressure reduced perigee height by 44 km. The approximate value of 1.1×10^{-18} g/cm^3 was obtained for the average air density at the 1600-km altitude of the satellite.

51 OBSERVED SOLAR PRESSURE PERTURBATIONS OF ECHO I.
D.O.Muhleman, R.H.Hudson, D.B.Holdridge, R.L.Carpenter and K.C.Oslund.
Science (USA), Vol. 132, 1487 (Nov. 18, 1960).

During the period 13-22 Aug. 1960, day-to-day determinations of the average orbital elements of the 100-foot Echo I balloon, based on observations taken at the Jet Propulsion Labortory's Goldstone tracking station, indicated a decrease in perigee height of 3.0 km/day and an increase in the eccentricity of 0.00038 per day.

525

52 THE CONTRACTION OF SATELLITE ORBITS UNDER THE INFLUENCE OF AIR DRAG. I. WITH SPHERICALLY SYMMETRICAL ATMOSPHERE.
G.E.Cook, D.G.King-Hele and D.M.C.Walker.
Proc. Roy. Soc. A (GB), Vol. 257, 224-49 (Sept. 6, 1960).

The effect of air drag on satellite orbits of small eccentricity e (< 0.2) is studied analytically by a perturbation method, on the assumption that the atmosphere is spherically symmetrical. Equations are derived which show (1) how perigee distance and orbital period vary with eccentricity as the orbit contracts, and (2) how each of these quantities varies with time. The equations of type (1) are nearly independent of the oblateness of the atmosphere. In all the equations, terms of order e^4 and higher are usually neglected. The results are also presented graphically, in a manner designed for practical use.

CHARACTERISTICS OF THE EXTRATERRESTRIAL CURRENT SYSTEM. EXPLORER VI AND PIONEER V. See Abstr. 21318 of 1960.

SOME PRELIMINARY RESULTS OF THE PIONEER V MAGNETOMETER EXPERIMENT. See Abstr. 21317 of 1960.

THE RECOVERY OF COSMIC-RAY EMULSIONS FROM ROCKET AND SPACE PROBES. See Abstr. 20251 of 1960.

PHYSICS

GENERAL

53 PROGRESS OF THE PHYSICAL AND TECHNICAL SCIENCES IN LATVIAN SSR. A.Malmeister.
Latv. PSR Zinat. Akad. Vestis (USSR), No. 7(156), 39-48 (1960).
In Russian.

54 ADDITION TO THE PHYSICS BUILDING AT THE UNIVERSITY OF TEXAS. R.B.Watson.
Amer. J. Phys., Vol. 29, No. 1, 50-6 (Jan., 1961).

53 : 539.11
SUPER-WEAK INTERACTIONS AND THE STABILITY OF MATTER. See Abstr. 20035 of 1960.

GRAVITATION . RELATIVITY

55 THE POSSIBILITY OF PERFORMING LABORATORY EXPERIMENTS TO MEASURE THE RATE OF DIFFUSION OF THE GRAVITATIONAL INTERACTION.
V.B.Braginskii, D.D.Ivanenko and G.I.Rukman.
Zh. eksper. teor. Fiz. (USSR), Vol. 38, No. 3, 1005-7 (March, 1960).
In Russian.

An experiment is proposed for the verification of a prediction of the general theory of relativity, namely the rate of diffusion of the gravitational interaction. It is shown that if a piezoelectric crystal were set up between two large masses there should arise a potential ~ 10^{-10} V, which it is possible to measure. [English translation in: Soviet Physics—JETP (USA), Vol. 11, No. 3, 723-4 (Sept., 1960)]. A.M.Green

56 THE EINSTEINIAN STATICS IN CONFORMAL SPACE. V.A.Fok.
Zh. eksper. teor. Fiz. (USSR), Vol. 38, No. 5, 1476-85 (1960).
In Russian.

A new definition is proposed for a three-dimensional spatial metric that corresponds to a given four-dimensional space—time metric. The space with a metric so defined is called conformal space. It is shown that the equations of Einsteinian gravitation statics in conformal space are simple in form and lead to definite expressions for the energy density and for the gravitational stresses. The cases of spherical and of axial symmetry are considered. It is pointed out that the notion of conformal space can be useful in the general non-static case as well. [English translation in: Soviet Physics—JETP (USA)].

ABSENCE OF BOUND STATES IN A GRAVITATIONAL FIELD. See Abstr. 20057 of 1960.

57 ON THE GENERAL FORM OF THE SPECIAL THEORY OF RELATIVITY. M.Z.v.Krzywoblocki.
Acta phys. Austriaca, Vol. 13, No. 4, 387-94 (1960).

The equations of the special theory of relativity are derived under the assumption that the reference velocity, which is assumed to be a constant in the classical form of the special theory, is a variable function of position and time.

58 ON THE RELATIVITY OF UNIFORM ROTATION. A.J.Das.
Indian J. theor. Phys., Vol. 7, No. 2, 33-40 (June, 1959).

The meaning of uniform rotation is properly analysed and clarified in the light of the principle of relativity. It is shown that uniform rotation is not an absolute motion and there exists a special relativity of uniform rotation.

59 REST MASS OF A FREE PARTICLE. I.Reff.
Amer. J. Phys., Vol. 28, No. 8, 745-6 (Nov., 1960).

60 LINEAR RELATIVISTIC HAMILTONIAN AND THE ELECTROMAGNETIC FIELD.
K.C.Kar and S.Purkayastha.
Indian J. theor. Phys., Vol. 7, No. 2, 25-32 (June, 1959).

The direct method and the method of taking the wavestatistical average, for the linearisation of the relativistic Hamiltonian without matrices are discussed. It is shown that the relativistic Hamiltonian is a world vector in the space-time continuum. The linear Hamiltonian without matrixes for a charged particle in the electromagnetic field is also studied. It is shown that the well known term involving H representing the energy of a magnetic dipole, comes out on recombining the two linear Hamiltonian in the electromagnetic field.

61 CANONICAL VARIABLES, EXPRESSION FOR ENERGY, AND THE CRITERIA FOR RADIATION IN GENERAL RELATIVITY. R.Arnowitt, S.Deser and C.W.Misner.
Nuovo Cimento (Italy), Vol. 15, No. 3, 487-91 (Feb. 1, 1960).

A canonical form for general relativity involving only two pairs of unconstrained conjugate variables is obtained by an orthogonal decomposition of the space part of the metric and the conjugate momentum variables, of the form

$$f_{ij} = f_{ij}^{TT} + \tfrac{1}{2}\,[f^{T}\delta_{ij} - (1/\nabla^2)f^{T}{}_{,ij}] + f_{i,j} + f_{j,i},$$

($1/\nabla^2$ the inverse of the flat space Laplacian, with appropriate boundary conditions). The coordinate conditions (without which the decomposition is meaningless) are

$$g_{ij,j} = 0, \quad \pi^{ii}{}_{,jj} - \pi^{ij}{}_{,ij} = 0.$$

The criterion for the existence of radiation at a point is then a non-zero TT part of the metric (or conjugate variable). C.W.Kilmister

62 ON THE DISTRIBUTION OF ENERGY IN THE SCHWARZSCHILD FIELD. F.R.Tangherlini.
Nuovo Cimento (Italy), Vol. 15, No. 5, 835-9 (March 1, 1960).

The Hamiltonian density assigned by Arnowitt, Deser and Misner (preceding abstract) to the gravitational field is criticized because it gives a non-positive-definite energy for the Schwarzschild field. Since the formulation was with a view to quantization, it is conjectured that this defect will lead to difficulties. Requirements that it is reasonable to put on the energy density are listed and it is conjectured that the only tensor satisfying them is, in fact, just Einstein's cosmical term. Some consequences of this are considered. C.W.Kilmister

63 ON THE POSSIBILITY OF TERRESTRIAL TEST OF THE GENERAL THEORY OF RELATIVITY.
C.Møller.
Nuovo Cimento Suppl. (Italy), Vol. 6, No. 1, 381-98 (1957).

A discussion of various terrestrial and earth satellite experiments involving the use of maser clocks. Formulae for the frequency of light emitted from an atomic system moving in a gravitational field, for the rate of an atomic clock in an earth satellite and for the velocity of propagation of radiation in a medium at rest in a gravitational field are derived in appendices. R.A.Newing

EVOLUTION IN GENERAL RELATIVITY. See Abstr. 11

QUANTUM THEORY

(Applications of quantum theory to elementary particles and nuclei are included under Nuclear Field Theory)

64 NOTE ON GAUGE TRANSFORMATIONS IN QUANTUM MECHANICS. A.O.Barut and M.Leiser.
Amer. J. Phys., Vol. 29, No. 1, 24-6 (Jan., 1961).

Gauge transformations are treated from the point of view of unitary transformations in ordinary quantum mechanics. Gauge-independent form of the constants of the motion is discussed. It is shown that the orbital angular momentum in an arbitrary gauge is given by

$$r \times [(p - eA) + \tfrac{1}{2}e(B \times r)].$$

65 ENERGY LEVELS OF A BOUNDED LINEAR HARMONIC OSCILLATOR BY THE METHOD OF BOUNDARY

PERTURBATION. K.K.Singh.
Proc. Nat. Inst. Sci. India A, Vol. 25, No. 6, 295-300 (Nov., 1959).

Continuing the work of an earlier paper by Baijal and Singh (Abstr. 6392 of 1956), analytical expressions have been obtained to represent the energy levels of a bounded linear harmonic oscillator for large values of the boundary parameter. The problem is viewed as one involving perturbation of the boundary and calculations are made to the second order of approximation. The first order result agrees with that obtained by Hull and Julius (Abstr. 8004 of 1956) by a different approach.

CONNECTION FORMULAE FOR W.K.B. SOLUTIONS WITH TWO TURNING POINTS. See Abstr. 2

STATISTICAL MECHANICS TRANSFER PROCESSES

66 THEORY OF GENERALIZED ENSEMBLES. A.Münster.
Molecular Phys. (GB), Vol. 2, No. 1, 1-7 (Jan., 1959). In German.

It is shown that the density operator of a generalized ensemble has to satisfy certain conditions if one wants to derive the equations of thermodynamics and correct fluctuation formulae. The pressure ensemble proposed by Byers Brown (Abstr. 2815 of 1958) is consistent with thermodynamics but it leads to wrong fluctuation formulae, especially to a wrong formulae for the light scattering of a one-component system. This is explained by the fact that in the Byers Brown ensemble the fluctuations have been partially discarded from the very beginning.

67 PRESSURE-DEPENDENT PARTITION FUNCTIONS. R.A.Sack.
Molecular Phys. (GB), Vol. 2, No. 1, 8-22 (Jan., 1959).

It is shown that the partition functions relating to statistical ensembles can be classified as cumulative, distributive or differential with regard to any of the extensive thermodynamic variables. The Laplace transforms involved in the general formulation of transformed partition functions, when extensive parameters are replaced by their conjugate intensive variables, are two-sided and appear in different forms according to the classification mentioned. The petit partition function at constant pressure can be defined for both classical and quantal systems as a Stieltjes integral or dimensionless Laplace transform over the volume-dependent partition function. This expression contains no arbitrary external parameters and satisfies all the conditions formulated by Münster (see preceding abstract); it can be interpreted as the ratio of two partition functions, the one relating jointly to the system and a macroscopic boundary, and the second to the boundary alone. It is known that the constant-pressure grand partition function as defined by Guggenheim (1939) diverges for all thermodynamically compatible values of its independent variables. It is shown that the Gibbs—Duhem relation, and hence all the statistical properties of the system, except its size, can be derived by differentiating the reciprocal of this, or a similarly defined, function, not its logarithm as with other partition functions. The mathematical differences arising out of the various proposed definitions are illustrated in a number of simple examples.

68 GREEN FUNCTION METHOD IN QUANTUM-STATISTICS. H.Kanazawa and M.Watabe.
Progr. theor. Phys. (Japan), Vol. 22, No. 2, 466-8 (Sept., 1959).

An equation for the partition function in terms of the temperature dependent two-particle Green function is derived. The relation of this equation to various approximation schemes is sketched.
D.J.Thouless

69 THE DEFINITION OF ENTROPY IN NON-EQUILIBRIUM STATES. N.G.van Kampen.
Physica (Netherlands), Vol. 25, No. 12, 1294-1302 (Dec., 1959).

Several different expressions are used in statistical mechanics for the entropy. They are here evaluated explicitly for non-equilibrium states. The result consists of three terms: (i) the equilibrium entropy; (ii) the familiar quadratic term measuring the departure from equilibrium; (iii) a term referring to the fluctuations. Only the last term differs for the several expressions for the entropy. However, it is much smaller than the second term when the departure from equilibrium is large compared to the size of the fluctuations.

70 ON THE THEORY OF BROWNIAN MOTION AND SPIN RELAXATION. T.Kotera and M.Toda.
J. Phys. Soc. Japan, Vol. 14, No. 11, 1475-90 (Nov., 1959).

The Brownian motion of a harmonic oscillator is treated quantum mechanically and the same method is applied to the relaxation of a spin. The method is quite general and applicable to a system displaced from the equilibrium state by an arbitrary amount initially. The oscillator or the spin is interacting with a thermostat composed of a great number of harmonic oscillators. The equation of motion is solved in operator form using the thermostat model to the second order of the interaction parameter. The Langevin equation, the Kramers—Chandrasekhar equation for a harmonic oscillator and the Bloch equation for a static field are derived.

71 ON THE GENERALIZATION OF THE VARIATIONAL METHOD OF BOGOLJUBOV. J.Czerwonko.
Bull. Acad. Polon. Sci. Ser. Sci. math. astron. phys. (Poland), Vol. 7, No. 10, 639-41 (1959).

Lower and upper bounds for the partition function in classical statistical mechanics are obtained.
D.J.Thouless

72 ON CERTAIN FUNDAMENTAL CONCEPTS OF CLASSICAL AND QUANTUM KINETIC THEORY OF GASES. C.G.Whittenbury and M.Z.v.Krzywoblocki.
Acta phys. Austriaca, Vol. 13, No. 4, 395-472 (1960).

A new attack is made upon the many-body problem, phase space being divided into domains characterised by the types of particle interactions taking place. It is claimed that many known results follow as special cases of the new treatment. No attempt is made to solve the equations, but it is suggested that the method may serve as a guide to the construction of models in particular cases. 25 References.
H.N.V.Temperley

73 AN ALTERNATIVE APPROACH TO THE ERGODIC PROBLEM. J.M.Blatt.
Progr. theor. Phys. (Japan), Vol. 22, No. 6, 745-56 (Dec., 1959).

The usual approach to the ergodic problem makes use of the idea of "coarse-graining", i.e., a macroscopic observer is supposed to be limited to "coarse-grained" experiments, and the resultant lack of complete information about the system gives rise to the irreversible increase of the (coarse-grained) entropy. It is shown that this approach is untenable, since macroscopic observers are not restricted in principle to coarse-grained experiments, and in fact one "fine-grained" experiment has already been carried out. An alternative approach is presented which avoids these difficulties. The irreversible increase of entropy is due to molecules outside the system proper, which collide with the outside of the box enclosing the system; this leads to a truly random, in principle unpredictable perturbation, which can be treated only stochastically. The number of particles within the system is irrelevant for this purpose, and in particular need not be large.

74 AN EXTENSION OF BOLTZMANN'S H-THEOREM. S.Simons and P.J.Higgins.
Phil. Mag. (GB) (Eighth Ser.), Vol. 4, 1282-3 (Nov., 1959).

The H-theorem is proved for a gas enclosed in a finite vessel, whose walls scatter the gas molecules in any prescribed manner.
H.N.V.Temperley

75 THERMODYNAMICALLY EQUIVALENT HAMILTONIAN FOR SOME MANY-BODY PROBLEMS. G.Wentzel.
Phys. Rev. (USA), Vol. 120, No. 5, 1572-5 (Dec. 1, 1960).

A method which allows a rigorous treatment of the statistical mechanics of a superconductor (Bardeen—Cooper—Schrieffer model) is generalized so as to be applicable to a wide class of many fermion or many-boson systems. As an illustration, a degenerate boson gas is studied, adopting the "pair Hamiltonian" of Girardeau and Arnowitt. Their finding for this model, that there is a "gap" in the energy spectrum of the lowest excitations, is confirmed.

76 INERTIAL MOMENT OF LARGE MANY-FERMION SYSTEMS WITH REPULSIVE INTERACTIONS. R.M.Rockmore.
Phys. Rev. (USA), Vol. 120, No. 6, 1933-42 (Dec. 15, 1960).

Interaction effects on the moment of inertia of a large many-body fermion system moving under periodic boundary conditions are explicitly derived in the second order of particle—particle coupling for the case of nonsingular repulsive interparticle forces. The derivation is facilitated by the use of a new Hamiltonian constructed by canonical transformation. This transformation is determined by equiring that it remove the compensating effects of pair excitation nd that the new interaction operators of first and second order in he cranking field be also of first order in particle–particle coupling. graphical analysis is presented in which those classes of diagrams hich yield corrections vanishing relative to the rigid moment in he limit L → ∞ are distinguished. Some remarks on the related roblem of diamagnetism are made. The possible application of the ethod of canonical transformation to related many-body problems s indicated.

77 LINKED-CLUSTERS EXPANSION IN QUANTUM STATISTICS: PETIT CANONICAL ENSEMBLE.
.Brout and F.Englert.
hys. Rev. (USA), Vol. 120, No. 5, 1519-27 (Dec. 1, 1960).

A linked-cluster expansion for the free energy in the petit nonical ensemble is presented and proved. It has the advantage avoiding the introduction of the unknown chemical potential in e perturbation series. As a consequence of correlations among e population numbers n(k), additional linkages representing these orrelations appear. The result is used to find the ground-state nergy of a many-body fermion system. This expression reduces to e Brueckner–Goldstone expansion only in the case of central forces an isotropic system, a theorem due to Kohn, Luttinger, and Ward. is also shown that, in the random phase approximation, correlation onds do not contribute. Finally, the relation of this formalism to e Bloch–De Dominicis expansion for the grand partition function discussed.

78 DISTRIBUTION FUNCTIONS AND QUANTUM STATISTICS. R.U.Ayres.
hys. Rev. (USA), Vol. 120, No. 5, 1557-71 (Dec. 1, 1960).

A formulation of quantum statistical mechanics is given, in rms of distribution functions. It is shown that all quantities of terest are obtained directly from nonlocal distribution functions

$$\gamma^{(1)}(x_1', x_1, \beta), \qquad \gamma^{(2)}(x_1', x_2', x_1 x_2, \beta), \ldots .$$

a uniform system the Fourier transform of $\gamma^{(1)}(x_1', x_1, \beta)$ is the stribution of particles in k space, $n(k, \beta)$. Various schemes for lculating these distribution functions directly are discussed. An oproximate integral equation for $n(k, \beta)$ is found, which can be olved by a converging iteration process. Some remarks are inuded on the application of the virial theorem.

79 ODD VARIABLES AND THERMODYNAMICS.
K.Okano.
ci. Pap. Inst. Phys. Chem. Res (Japan), Vol. 54, 1-5 (March, 1960).

Invoking the invariance character of the free energy with time eversal, the possibility is discussed of the occurrence of linear ouplings between even and odd variables.

80 THE HOPF q-FUNCTION SIMPLY AND PRECISELY EVALUATED. J.I.F.King.
strophys. J. (USA), Vol. 132, No. 2, 509-11 (Sept., 1960).

It is shown that the source function for the equilibrium problem f radiation transfer in a plane parallel atmosphere can be very ccurately represented by a linear function of the second and third rder exponential integrals. Application of the Milne–Schwarzschild perator leads to an even better solution (maximum error about .02%). An application of the method "non-grey" finite atmospheres s suggested. H.N.V.Temperley

81 THE CONSTANT FLUX PROBLEM IN NON-UNIFORM EXPONENTIAL MEDIA. P.R.Wilson.
ustral. J. Phys., Vol. 13, No. 3, 461-9 (Sept., 1960).

A description is given of radiative transfer, under conditions of onstant flux, in a semi-infinite medium in which the attenuation coefficient increases exponentially with depth, and has small sinusoidal ariations in a direction parallel to the surface. The directional intensity at the surface is evaluated numerically in several cases, and he extrapolation to other cases is discussed.

GENERAL MECHANICS

82 PERTURBATIONS IN CLASSICAL MECHANICS.
L.M.Garrido.
roc. Phys. Soc. (GB), Vol. 76, Pt 1, 33-5 (July, 1960).

Describes a method of evaluating perturbations in classical echanics which is similar to quantum mechanics time-dependent erturbation theory.

83 TRANSVERSE BENDING OF AN INFINITE PLATE WITH A CYLINDRICAL CIRCULAR HOLE BY THE THREE-DIMENSIONAL THEORY OF ELASTICITY.
I.Nakahara and T.Koizumi.
Bull. JSME (Japan), Vol. 3, No. 9, 66-71 (Feb., 1960).

84 A PLANE DYNAMIC PROBLEM OF THERMO-ELASTICITY CONCERNING A CIRCULAR HOLE.
J.Ignaczak.
Bull. Acad. Polon. Sci. Ser. Sci. tech. (Poland), Vol. 7, No. 7-8, 469-75 (1959).

85 A CERTAIN DYNAMIC PROBLEM OF THERMO-ELASTICITY CONCERNING THE CIRCULAR DISC.
W.Piechocki.
Bull. Acad. Polon. Sci. Ser. Sci. tech. (Poland), Vol. 7, No. 9, 513-18 (1959).

86 THERMAL STRESSES DUE TO A THERMAL INCLUSION IN A CIRCULAR RING AND A SPHERICAL SHELL.
W.Piechocki and J.Ignaczak.
Bull. Acad. Polon. Sci. Ser. Sci. tech. (Poland), Vol. 7, No. 7-8, 419-24 (1959).

87 STRENGTH OF AN UNLIMITED DISC WITH A RIGID MEDIUM. H.Czudek.
Bull. Acad. Polon. Sci. Ser. Sci. tech. (Poland), Vol. 7, No. 7-8, 425-30 (1959).

88 THE ACTION OF A CONCENTRATED MOMENT ON A HALF-PLANE DISC. F.Szelągowski.
Bull. Acad. Polon. Sci. Ser. Sci. tech. (Poland), Vol. 7, No. 9, 503-6 (1959).

89 A SEMI-INFINITE PLATE UNDER THE ACTION OF INTERNAL LOAD. F.Szelągowski.
Bull. Acad. Polon. Sci. Ser. Sci. tech. (Poland), Vol. 7, No. 7-8, 431-6 (1959).

90 THE PROBLEM OF A PLATE STRIP UNDER EXTERNAL LOAD. F.Szelągowski.
Bull. Acad. Polon. Sci. Ser. Sci. tech. (Poland), Vol. 7, No. 9, 507-12 (1959).

91 TORSION AND BENDING OF AN AEOLOTROPIC BEAM HAVING A CURTATE SECTION. A.Chakravorti.
Indian J. theor. Phys., Vol. 7, No. 1, 17-24 (March, 1959).

Following the semi-inverse method of St. Venant, components of stress associated with torsion and bending of an aeolotropic beam are obtained in this paper. The cross-section of the beam considered is a curvilinear rectangle bounded by two concentric circles and two radii.

92 NOTE ON THE UNIQUENESS OF SOLUTION OF PROBLEMS CONNECTED WITH THIN PLATES BENT BY NORMAL PRESSURES. B.Sen.
Indian J. theor. Phys., Vol. 7, No. 2, 41-4 (June, 1959).

The object of this note is to prove that the solution of the problem of a thin plate which is in a state of uniform tension, and is bent by normal pressures, is unique for different edge conditions.

93 DIGITAL COMPUTER ANALYSIS OF INFLUENCE COEFFICIENTS FOR DEFLECTION AND BENDING MOMENT OF ORTHOTROPIC PARALLELOGRAM PLATES.
M.Naruoka and H.Omura.
Mem. Fac. Engng Kyoto Univ. (Japan), Vol. 21, Pt 2, 103-27 (April, 1959).

The skew network finite difference equation for the differential equation of equilibrium on the middle surface of the orthotropic parallelogram plate, expressed in Cartesian coordinates,

$$B_X \frac{\partial^4 w}{\partial x^4} + 2H \frac{\partial^4 w}{\partial x^2 \partial y^2} + B_Y \frac{\partial^4 w}{\partial y^4} = p$$

was proposed for the general case, $0 \leq \kappa = H/\sqrt{B_X B_Y} \leq 1$, and for the special boundary conditions where the plate is supported simply at the two opposite skew sides and supported by flexible girders at the other two sides. Dividing the parallelogram plate into six equidistant lengths in the direction of the span and also perpendicular to the span, and then applying the skew network finite difference equation, the influence coefficients of deflection and bending moment were calculated by the use of digital computers, UNIVAC-120 and Bendix G-15D, for the two cases of variables.

94

ON POST-CRITICAL DEFORMATIONS OF COMPRESSED CYLINDRICAL SHELLS. A.V.Pogorelov.

Dokl. Akad. Nauk SSSR, Vol. 134, No. 1, 62-3 (Sept. 1, 1960). In Russian.

A post-critical deformation occurs when a cylindrical shell changes its overall geometrical shape when loaded axially; the loading corresponding to such deformation, p^*_{cr} is lower than the ordinary critical loading. Assuming periodic deformation along the length of the shell, it is concluded that $p^*_{cr} = 0.15Ed/R$ (E-modulus of elasticity; d = thickness and R = radius of the shell) for certain specified degree of periodic deformation.

J.K.Skwirzynski

95

STRESSES DUE TO A NUCLEUS OF THERMO-ELASTIC STRAIN (i) IN AN INFINITE ELASTIC SOLID WITH SPHERICAL CAVITY AND (ii) IN A SOLID ELASTIC SPHERE. B.D.Sharma.

Z. angew. Math. Phys. (Switzerland), Vol. 8, No. 2, 142-50 (March 25, 1957).

The stresses and displacements on the surface of a spherical cavity contained within an infinite elastic solid at zero temperature and situated at a finite distance from a heated element are calculated using the Boussinesq approach and are depicted in graphical form. The results are compared with those for the case of a circular hole in an infinite plate. Another problem solved is the case of a solid sphere at zero temperature having a heated element inside it.

H.J.H.Starks

96

SMALL DEFORMATIONS SUPERPOSED ON FINITE DEFORMATIONS OF A CURVILINEARLY ORTHOTROPIC BODY. W.Urbanowski.

Bull. Acad. Polon. Sci. Ser. Sci. tech. (Poland), Vol. 7, No. 7-8, 437-43 (1959).

97

ON THE PHOTOELASTIC EXAMINATION OF VIBRATING BODIES AND THE PHOTOELASTIC EFFECT IN OPTICALLY ACTIVE MEDIA. A.F.B.Wood.

J. Mech. Phys. Solids (GB), Vol. 8, No. 1, 26-38 (Jan., 1960).

The interpretation of the photoelastic stress patterns of vibrating bodies is discussed, with particular reference to quartz crystals. An expression is derived for the change in velocity of a light wave propagated along the optic axis due to stesses acting in the plane normal to this axis. Such stresses should cause an increase in the effective rotary power and this is verified by experiment. This result offers an explanation of phenomena observed by earlier workers.

98

A REVERSED LOOP-THE-LOOP. R.M.Sutton.

Amer. J. Phys., Vol. 29, No. 1, 50-6 (Jan., 1961).

By relying on the complete similarity of an accelerated coordinate system with a gravitational field, a simple accelerated loop-the-loop is described, by which a ball starting at the bottom rolls backward up over a loop and is caught at the top. Simple means of accelerating the apparatus suffice.

99

THE MOTION OF A PENDULUM WHOSE SUPPORTING AXIS MOVES TWO DIMENSIONALLY. R.Adachi.

Kumamoto J. Sci. A (Japan), Vol. 4, No. 3, 192-204 (Feb., 1960).

Usually the vibrations of various structures are observed using a vibroscope, which is often a pendulum of some sort. For this type of instrument, when recording one component of vibration (horizontal or vertical), the relation between the record obtained and the original vibration is only known if the other component is zero. In this paper the problem is tackled generally, and the solution for the motion of a pendulum is found provided the two components of motion of the supporting axis is known. Some special cases and an example are discussed.

H.Morrison

MECHANICAL MEASUREMENTS

100

A LARGE-RANGE PNEUMATIC EXTENSOMETER. N.L.Svensson.

Proc. Instn Mech. Engrs (GB), Vol. 173, No. 7, 233-8 (1959).

The design and development are described of an extensometer suitable for the measurement of axial strains of the order 10^{-5} over a range of ±20 per cent, using a 1 in. gauge length. The pneumatic gauge is capable of measuring strains less than 10^{-5} over a range of approximately 4×10^{-3}, thus ensuring adequate measurement of elastic and initial plastic strains. A micrometer screw is used for adjustment to cover the large range and is suitable for measurement of gross plastic strains. The mechanism of the instrument was designed to comply with the following requirements: (1) magnification linear with strain; (2) nozzle and micrometer spindle to be maintained parallel; (3) insensitive to bending strains; (4) accommodate changes in specimen diameter without adjustment. Consideration of these requirements led to the choice of a parallel-motion mechanism made in two halves to allow for changes in specimen diameter. The measuring units were so placed as to measure the mean strain between the gauge points. The method of calibration is described and also the method of analysing the results for comparison with the theoretical expression derived. This calibration and subsequent use of the instrument have shown that all the requirements listed above have been adequately satisfied.

101

AN AUTOMATIC PARTICLE COUNTER AND SIZER. H.A.Dell, D.S.Hobbs and M.S.Richards.

Philips tech. Rev. (Netherlands), Vol. 21, No. 9, 253-67 (1959-60).

Various possible scanning systems are described, together with various methods to avoid or allow for the effects of multiple or lumped counts. It is shown that flying-spot scanning, together with a line-to-line memory, represents a very effective solution to the problem. Sizing can be performed by logical circuits that reject pulses shorter than a certain pre-set length. The Mullard particle analyser is described. The sample is in the form of a 35 mm photograph (negative or positive) made from the original sample by direct photography, photomicrography or electron microscopy. This greatly simplifies the optical arrangements. With the aid of block diagrams and waveforms it is shown in detail how the instrument makes total counts and measures size distributions. The operation of some of the sub-units is explained with the aid of simplfied circuit diagrams. Resolution is discussed and a section on initial adjustments and calculation, and some results which demonstrate the reproducibility of the instrument, are given.

102

GIMBAL DEVICE TO MINIMIZE THE EFFECTS OF OFF-CENTER LOADING ON BALANCE PANS.

H.A.Bowman and L.B.Macurdy.

J. Res. Nat. Bur. Stand. (USA), Vol. 64 C, No. 4, 277-9 (Oct.-Dec, 1960).

Failure to centre loads on laboratory-balance pans results in swinging and vibration of the suspension upon release, both of which contribute to weighing error. As part of a study of balance design in relation to sources of uncertainty, a device has been contrived which, when installed in the suspension, locks the suspension in a gravitationally alined configuration after loading but prior to beam release. Data are presented showing significant reduction of the effects of off-centering after the device has been operated.

103

RESPONSE OF MICROCHEMICAL BALANCES TO CHANGES IN RELATIVE HUMIDITY. H.E.Almer.

J. Res. Nat. Bur. Stand. (USA), Vol. 64C, No. 4, 281-5 (Oct.-Dec, 1960).

The effects of relative humidity were investigated on four microchemical balances (two equal-arm two-pan and two one-pan direct reading). Tests were begun by reading the balance indications at low relative humidities; humidified air was then introduced into the balance case and balance indication and hygrometer readings were taken as the moist air was gradually replaced by drier room air. Individual balance parts which were suspected of mass changes with relative humidity were separately weighed at controlled humidities by a balance operated in uniform, rather dry room air. The balances all responded rapidly to changes in humidity and quickly reached new equilibria. All but one of the four balances — a one-pan balance — responded systematically. Largest changes in balance indication with humidity were found to be caused by hygroscopic materials used in construction. Foreign hygroscopic material on live parts of balances would be equally damaging. The effects are not predictable even after balances of a given design have been studied, so in practice each balance should be tested. If changes with humidity are not negligible, hygroscopic materials must be removed as far as practicable. With a good balance, a small variation in humidity may be disregarded.

Bi FILM STRAIN GAUGES AND DISPLACEMENT TRANDUCERS. See Abstr. 21253 of 1960.

104 FREQUENCY CONTROL SYMPOSIUM.
G.K.Guttwein and H.H.Plotkin.
ys. Today (USA), Vol. 12, No. 11, 36-8, 40, 42 (Nov., 1959).

Report of the 13th Annual Symposium sponsored by the Frequency ontrol Division of the U.S. Army Signal Research and Development aboratory. It was held on 12-13, May 1959 at Artbury, New Jersey. extremely wide field was covered, papers ranging from a con- deration of how the ageing of the universe may affect gravitational d atomic time scales,to a report on mechanized plant for produc- g quartz crystals.

105 THE PULSE-PHASING DEVICE OF THE ELECTRO-MECHANICAL FREQUENCY DIVIDER OF A MASTER SCILLATOR FOR QUARTZ CLOCKS. S.S.Tovchigrechko.
stron. Zh. (USSR), Vol. 36, No. 6, 1130-3 (1959). In Russian.
nglish translation in: Soviet Astron. (USA), Vol. 3, No. 6, 1040-2 ay-June, 1960).

The device consists of a synchronous motor with reduction earing with two ouput spindles rotating at 1 rev/sec and 1 rev/min. cam mounted on each output spindle closes corresponding pairs flat contact springs which are carried on disks concentric with e spindles. The disks are provided with scales on their edges and ey can be rotated manually to set the pulse phasing within 5 msec rongly given as 5 μsec) for the seconds pulses, and 1 sec for the inute pulses. By comparison with external apparatus, the seconds ulses can be set within 0.1-0.2 msec. The 100-pole synchronous otor is fed with 1000 c/s a.c. derived from a quartz crystal scillator, and rotates at 600 rev/min. C.F.Pizzey

MECHANICS OF FLUIDS

(See also Magnetohydrodynamics)

106 ROTATION VISCOMETER FOR THE DETERMINATION OF VISCOSITY AT HIGH PRESSURES.
Holzmüller and R.Dinter.
per. Tech. der Phys. (Germany), Vol. 8, No. 3, 118-26 (1960). German.

A Couette viscometer is described that can be used at pressures to 3000 atm. The eccentricity and the temperature rise were omplication in the evaluation of the results. Silicones showed a viation from an exponential increase of the viscosity with pressure. R.Schnurmann

107 VISCOMETERS HAVING DAMPED TORSIONAL OSCILLATION.
.S.Ashwin, T.Hagyard, I.C.B.Saunders and T.E.Young.
sci. Instrum. (GB), Vol. 37, No. 12, 480-5 (Dec., 1960).

Two types of torsional pendulum viscometers, having only one lid-fluid boundary, have been developed specifically for use in uidized solids investigations. They may have utility also in coarse fibrous suspensions or in melts at high temperatures. The theory these viscometers is discussed and empirical correlations are esented whereby any instrument of these two types may be used th minimal or no calibration.

108 VISCOSITY OF DILUTE SOLUTIONS OF POLY-ELECTROLYTES. I.Sakurada and N.Ise.
em. Fac. Engng Kyoto Univ. (Japan), Vol. 21, Pt 3, 322-30 ly, 1959).

The viscosity measurements were performed with polyvinyl cohol partially acetalized with glyoxylic acid, in solutions of a nple electrolyte, using Pals and Hermans' method of dilution. was found that the extension of a macro-ion on the dilution line s kept constant over the polymer concentration range covered. parameter, m, introduced in the method of dilution was known to not far from the ratio of activity coefficients of polymeric and nple electrolytes. The "effective ionic strength" proposed by ls and Hermans was suggested to be a significant quantity in ute solutions of polyelectrolytes.

109 SOME MEASUREMENTS OF THE ELASTIC AND VISCOUS PROPERTIES OF THIXOTROPIC FLUIDS.
W.Billington.
roc. Phys. Soc. (GB), Vol. 76, Pt 1, 127-36 (July, 1960).

A coaxial cylinder viscometer is described which was designed measure the elastic and viscous properties of fluids which exhi- t thixotropic behaviour, in particular of natural "wax-containing" oils. A constant torque is applied to the inner cylinder which is free to rotate, while the outer cylinder is kept stationary. The change in the rate of shear with time for which the stress is applied can be measured. The shape of the resulting "rate of shear, time" graph can be interpreted so as to distinguish and measure the elastic and viscous properties. An example is given of the behaviour of a typical "wax-containing" oil together with a suggested quantitative interpretation of the results.

110 EQUATIONS OF RELAXATIONAL HYDRODYNAMICS.
E.V.Stupochenko and I.P.Stakhanov.
Dokl. Akad. Nauk SSSR, Vol. 134, No. 4, 782-5 (Oct. 1, 1960). In Russian.

Local deviations from thermal equilibrium are to be specified in terms of a parameter which is formally treated as if it were an observable quantity. Actually it is related to observation only by the way of two equations in the form of relations with the local energy and the local entropy. The two equations are to supplement the hydrodynamical equations of ideal liquids. It is found that in the limit of small deviations from ideal liquids, dissipation makes its appearance by the way of a volume viscosity; shear viscosity or thermal conductivity are not introduced either explicitly or by implication. R.Eisenschitz

111 SOME PROBLEMS IN HYDRODYNAMICS OF NON-NEWTONIAN VISCOUS LIQUIDS WITH VARIABLE COEFFICIENT OF CROSS-VISCOSITY. J.N.Kapur.
Proc. Nat. Inst. Sci. India A, Vol. 25, No. 5, 231-5 (Sept. 26, 1959).

It is shown that for plane flows, the cross-viscosity term does not affect the equation for vorticity, superposability condition, condition for circulation-preservation and the possibility of the use of inverse methods even when the variation in the coefficient of cross-viscosity is taken into account. It is also shown that Taylor's results for the rotation of an infinite rigid cylinder in a non-viscous liquid continue to hold for the most general non-Newtonian liquid.

112 SOME VARIATIONAL THEOREMS FOR NON-NEWTONIAN FLOW. M.W.Johnson, Jr.
Phys. of Fluids (USA), Vol. 3, No. 6, 871-8 (Nov.-Dec., 1960).

A new variational theorem is formulated which has as its Euler equations and natural boundary conditions all of the differential equations and boundary conditions of the boundary values problems under consideration. Other variational theorems, including the classical theorems of Helmholtz, follow from this fundamental theorem. Conditions under which the theorems obtained are minimum or maximum principles are discussed and application to non-Newtonian flow in a tube is made.

113 A BOUNDARY LAYER PROBLEM IN WHICH THE EXTERNAL FLOW HAS A FREE SURFACE.
W.I.Axford.
New Zealand J. Sci., Vol. 3, No. 3, 399-409 (Sept., 1960).

The interaction of viscous and gravitational effects is examined for the case of a semi-infinite flat plate held in a horizontal plane beneath the free surface of a uniform stream. Approximate solutions are found for the boundary layer and the external flow using the assumption that the boundary layer is thin compared with the depth of the plate beneath the free surface. A solution is also given for the case of yawed flow.

114 FORMATION OF THIN FLAT SHEETS OF WATER.
G.Taylor.
Proc. Roy. Soc. A (GB), Vol. 259, 1-17 (Nov. 22, 1960).

A thin plane sheet of fluid which is limited laterally and converges toward a point transforms itself into a sheet which diverges in a perpendicular plane. When the angle of convergence is small and the distribution of thickness in the converging sheet is elliptic the diverging sheet has the same shape as the converging sheet. Apparatus for producing such a sheet was set up and the shape of the stream and distribution of pressure in the region of the transformation were measured and compared with calculations. The formation of thin sheets by the oblique impact of two cylindrical jets was studied and the distribution of thickness measured. The shapes of sheets corresponding to the measured distribution of thickness were calculated and compared with photographs.

115 FLOW OF A VISCO-ELASTIC LIQUID NEAR A STAGNATION POINT. S.K.Sharma.
J. Phys. Soc. Japan, Vol. 14, No. 10, 1421-5 (Oct., 1959).

Equations of motion for the flow of a viscoelastic liquid near a stagnation point, occurring when a stream of such a liquid impinges on a wall at right angles to it and flows away radially in all directions, have been set up and solved by the Karman–Pohlhausen method. The effect of elasticity is found to depend upon a non-dimensional parameter $\tau^* = \tau a$ (where τ is the flow parameter or the relaxation time constant and a is a constant of dimensions T^{-1} depending on the velocity in potential flow). Behaviour for small values of this parameter has been studied. It is observed that the boundary layer thickness and the shearing at the wall increase with an increase in τ^*, while the normal stress at the wall is independent of both elasticity and viscosity. The stream lines get closer to the wall with an increase in the parameter.

116 THE FLOW OF A VISCOUS FLUID PAST A TRIANGULAR CYLINDER. M.Kawaguti.

J. Phys. Soc. Japan, Vol. 14, No. 10, 1425-31 (Oct., 1959).

The flow of a viscous fluid past an equilateral triangular cylinder is studied using Imai's method of treating Oseen's approximation. The expression for the velocity in the flow field near the triangular cylinder is obtained correct to the order of R^2, and those for the frictional, pressure and total drag to the order of R. The drag of the triangular cylinder at high Reynolds numbers is estimated by use of Imai's new theory of drag and is compared with Asaka and Oshima's experimental results.

117 REVERSAL FLOW THEOREM CONCERNING OSEEN'S APPROXIMATION. M.Kawaguti.

J. Phys. Soc. Japan, Vol. 14, No. 10, 1431-3 (Oct., 1959).

Simple relations are sought between the two-dimensional flow of a viscous fluid past a cylindrical obstacle and the flow past the same obstacle rotated by an angle π about its axis, within the accuracy of Oseen's approximation. It is shown that the forces acting upon the cylinder do not change by the rotation of the cylinder, as far as the terms of order $O(R^{-1})$ are concerned. Further, for the special cases of symmetrical obstacles which experience no lift, it is shown that the total drags for the original and the rotated bodies coincide with each other within the accuracy of O(R).

118 ON A METHOD OF SUCCESSIVE APPROXIMATIONS APPLIED TO THE AXISYMMETRIC FLOWS OF AN INCOMPRESSIBLE PERFECT FLUID. T.Simasaki and K.Niu.

J. Phys. Soc. Japan, Vol. 14, No. 12, 1810-15 (Dec., 1959).

The fundamental equation for the steady axisymmetric flow of an incompressible inviscid fluid is expressed in a complex form as:

$$\frac{\partial F}{\partial \zeta} = \frac{F - \overline{F}}{2(\zeta - \overline{\zeta})}$$

This is replaced by the following approximate equation:

$$F_N = \int \frac{F_{N-1} - \overline{F}_{N-1}}{2(\zeta - \overline{\zeta})} d\overline{\zeta} + g_N(\zeta),$$

where F_N and F_{N-1} are the N-th and the (N-1)th approximation of the complex velocity potential F respectively, and $g_N(\zeta)$ is an appropriate complementary function of ζ. Treatment of this equation is very simple and its validity is ascertained by numerical calculations for the cases of a sphere and prolate spheroid for which exact solutions are already known. In the case of a sphere, approximate solutions converge uniformly to the exact one, while in the case of a prolate spheroid it is seen that the velocity potential on the surface is rather rapidly improved step by step.

119 GENERAL THEORY ON STEADY BEHAVIOURS OF OPEN CHANNEL FLOWS BY MEANS OF ONE DIMENSIONAL PROCEDURES OF ANALYSIS. Y.Iwasa.

Mem. Fac. Engng Kyoto Univ. (Japan), Vol. 21, Pt 4, 348-66 (Oct., 1959).

This paper concerns the general theory of the steady behaviour of open channel flows using one dimensional analysis procedures. The theory described is essentially formed by the transitional characteristics of steady flows in channel transitions, and it can provide a unified treatment for the hydraulic behaviour of gradually varied flows, (which mainly deal with the determination of surface profiles of water and rapidly varied flows, with local variations of flow caused by sudden changes in channel characteristics.

120 FLUID FLOW THROUGH A POROUS CHANNEL. W.E.Wageman and F.A.Guevara.

Phys. of Fluids (USA), Vol. 3, No. 6, 878-81 (Nov.-Dec., 1960).

Approximate solutions of the equations of motions governing laminar incompressible fluid flow through a cylindrical channel with a porous wall are derived. The invalidity of an approximation in the solution of these equations under certain circumstances is pointed out, and the results of a numerical integration in the region where the approximation is invalid are indicated. A brief description is given of an experiment to verify the calculations, and some interesting results are noted.

121 FLOW PATTERNS OF LIQUIDS IN A CYLINDRICAL MIXING VESSEL WITH BAFFLES.

S.Nagata, K.Yamamoto, K.Hashimoto and Y.Naruse.

Mem. Fac. Engng Kyoto Univ. (Japan), Vol. 31, Pt 3, 260-74 (July, 1959).

122 RESISTANCE IN POTENTIAL FLOW OF REAL FLUIDS: PROLATE AND OBLATE SPHEROIDS.

N.L.Ghosh and H.K.Chatterjee.

Proc. Nat. Inst. Sci. India A, Vol. 25, No. 2, 83-98 (March, 1959).

123 FLOW PATTERN IN DIESEL NOZZLE SPRAY HOLES. W.Bergwerk.

Proc. Instn Mech. Engrs (GB), Vol. 173, No. 25, 655-60 (1959).

A study is presented of the flow in spray holes of 0.2 to 2.5 mm diameter and shows how the changes in cavitation pattern affect the appearance of the jet. The influence of the cavitation number, Reynolds number, the upstream edge sharpness, and the length/diameter ratio is investigated. A cavity first formed near the upstream corner, but soon caused the jet to leave the wall altogether so that only the upstream corner had any effect on the flow. Under non-cavitating conditions the emerging jet had a ruffled appearance, but under conditions when the jet had left the wall, it emerged smooth and glass-like. The glass-like stage could only be obtained with very accurately made spray holes, and any disturbance upstream such as occurs in actual Diesel nozzles, caused the jet to appear ruffled at all times. The discharge coefficient was found to vary with Reynolds number and cavitation number and a contour map covering Reynolds number of 1000 to 20 000 and cavitation number of 0.2 to 100 is presented.

124 DISCHARGE COEFFICIENT OF SMALL SUBMERGED ORIFICES. R.H.Spikes and G.A.Pennington.

Proc. Instn Mech. Engrs (GB), Vol. 173, No. 25, 661-6 (1959).

Deals with the variation in discharge of small submerged orifices used in aero-control systems. It is shown that the effects of cavitation can be high and can cause changes of discharge coefficient greater than those associated with Reynolds number when the flow is turbulent. The orifice length was altered and it was found that the most unstable conditions occurred when the length was half the diameter. Further tests were carried out with inlet chamfer in order to determine the optimum angle and depth of chamfer for cavitation suppression.

125 APPLICATION OF THE SIMILARITY PRINCIPLE TO THE STUDY OF OSCILLATIONS EXCITED BY CAVITATION. G.A.Khoroshev.

Akust. Zh. (USSR), Vol. 5, No. 4, 472-9 (1959). In Russian. English translation in: Soviet Physics–Acoustics (USA), Vol. 5, No. 4, 485-92 (April-June, 1960).

A system of defining criteria is obtained, making it possible, under definite conditions, to simulate oscillations in a fluid flow with caviation. The conditions for simulating oscillations of the walls that bound this fluid are given.

126 WAVES ON A SLOPING BEACH. W.E.Williams.

Proc. Cambridge Phil. Soc. (GB), Vol. 57, Pt 1, 160-5 (Jan., 1961).

A method employed by the author for a class of boundary-value problems arising in diffraction theory (Abstr. 3856 of 1960) is applied to the problem of the oscillations of water waves on a sloping beach. The two cases of long and short waves are considered. The approach is valid for all values of the parameters and particular cases do not have to be treated separately. It is shown that the present approach enables certain solutions to be obtained which cannot arise in earlier solutions of the problem.

127 SELF-INDUCED WAVES IN A CONDUIT WITH CORRUGATED WALLS. I. EXPERIMENTS WITH WATER IN AN OPEN HORIZONTAL CHANNEL WITH VERTICALLY CORRUGATED SIDES. A.M.Binnie.
Proc. Roy. Soc. A (GB), Vol. 259, 18-27 (Nov. 22, 1960).

The walls of a rectangular horizontal channel, the bottom of which was smooth, were lined with corrugated iron arranged to give a shore line of alternate bays and capes. When water passed through the channel with a well-marked critical velocity, a continuous train of self-induced waves was formed on the surface, and moved steadily upstream into the contraction which led from the supply reservoir. With a narrow stream the waves possessed horizontal transverse creats and troughs, but above a certain width the waves were antisymmetrical. With different combinations of channels and corrugations the mechanism was examined by which energy was taken from the stream to maintain the waves. Linings of rectangular capes and bays produced higher-order waves, and the effect was largely independent of the number of bays.

128 PORTABLE WATER VELOCITY METER.
J.M.Edington and L.Molyneaux.
J. sci. Instrum. (GB), Vol. 37, No. 12, 455-7 (Dec., 1960).

A development of the instrument described by Wilkie (Abstr. 536 of 1955) incorporating automatic compensation for changes in the conductivity of the water and utilizing transistors as the active circuit elements. As the instrument is small and light, and powered by a self-contained battery it is particularly suitable for field work.

129 UNDERSTANDING SURFACE TENSION.
G.D.Yarnold.
Contemporary Physics (GB), Vol. 1, No. 4, 267-75 (April, 1960).

This article discusses the presentation of the facts of capillarity at the level of the upper forms of schools or the first year of a university course. The usual formulae are derived consistently from energy considerations, and care is taken to justify such geometrical approximations as are unavoidable. A plea is made that the subject be taught from the beginning in terms of surface energy, so keeping in sight of physical reality.

130 DYNAMIC PROPERTIES OF THE SURFACE TENSION OF WATER AND AQUEOUS SOLUTIONS OF SURFACE ACTIVE AGENTS' WITH STANDING CAPILLARY WAVES IN THE FREQUENCY RANGE FROM 10 kc/s TO 1.5 Mc/s.
W.Eisenmenger.
Acustica (Internat.), Vol. 9, No. 4, 327-40 (1959).

Standing capillary waves were excited on the plane surface of water and aqueous solutions of surface active substances by means of rheolinear oscillations. Taking the theory of rheolinear oscillations as a basis, a method for measuring surface viscosity was developed. Measurements were made of the capillary wavelength (surface tension) on the capillary wave amplitude and the exciting frequency, of the relation between exciting amplitude and capillary wave amplitude, and of the absolute value of the exciting amplitude for the onset of capillary waves. The measured value for the surface viscosity of water is by one order of magnitude smaller than a value given in the literature. Another result is that some aqueous solutions of surface active substances have a noticeably higher surface viscosity. It is further shown that for water (frequencies about 1 Mc/s), as well as for aqueous solutions of surface active substances (lower frequencies), there exists an increase of the capillary wavelength and therefore also of the temporal mean value of the surface tension with rising capillary wave amplitude.

131 THE FLOW OF FLUIDS THROUGH CAPILLARIES, POWDER BEDS AND POROUS MEDIA. G.Maidanik.
Trans Faraday Soc. (GB), Vol. 56, Pt 1, 118-27 (Jan., 1960).

A semi-empirical theory is developed. The slip term is based on the interaction of the molecules of the fluid with the surfaces of the powder bed. This approach successfully bridges the gap between the hydrodynamic region and the diffusion region. The general features of the experimental results are accounted for.

132 THE FLATTENING OF DIELECTRIC LIQUID DROP IN A UNIFORM ELECTRIC FIELD.
N.K.Nayyar and G.S.Murty.
Proc. Nat. Inst. Sci. India A, Vol. 25, No. 6, 373-9 (Nov., 1959).

The equilibrium of a dielectric liquid spherical drop in the presence of uniform external electric field is studied. It is shown that the drop becomes spheroid under the influence of both electric field and surface tension.

133 THEORY OF GAS BUBBLE DYNAMICS IN OSCILLATING PRESSURE FIELDS.
M.S.Plesset and Din-Yu Hsieh.
Phys. of Fluids (USA), Vol. 3, No. 6, 882-92 (Nov.-Dec., 1960).

The behaviour of a permanent gas bubble in a liquid with an oscillating pressure field is analysed with a linearized theory. If the assumption is made that conditions within the bubble are uniform, the thermodynamic relations found are as expected; i.e., at low frequencies the bubble behaves isothermally and at high frequencies the behaviour becomes adiabatic. However, a more detailed analysis, which allows the bubble interior to vary not only in time but also in space, leads to an average isothermal behaviour for the bubble even in the high-frequency limit.

134 CINEMATOGRAPHIC INVESTIGATION OF SINGLE-BUBBLE CAVITATION. J.Schmid.
Acustica (Internat.), Vol. 9, No. 4, 321-6 (1959). In German.

By using the inertia forces which are set up by the sudden deceleration of a fast-moving liquid column and produce very low pressures therein, spherical cavitation bubbles of over 1 cm diameter can be produced in water. Cinematograph studies were made of the formation, collapse, and rebound of the bubbles, as well as of the very strong shock waves set up by the implosion. Similar experiments give rise to luminescence in glycerine.

EXPERIMENTS WITH VIBRATING SOAP FILMS.
See Abstr. 188

LIQUID STATE

(Liquid helium is included under Low-Temperature Physics)

135 HYDROSTATIC EFFECT IN LIQUIDS NEAR THE CRITICAL POINT. A.V.Voronel' and M.Sh.Giterman.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 4(10), 1162-3 (Oct., 1960). In Russian.

The isothermal derivative of the pressure with respect to the volume varies at the critical point linearly with the temperature and the square of the increment in volume. This corresponds to a parabolic graph representing the pressure or temperature as a function of the volume with a maximum at the critical volume. This relation is distorted by gravitational effects. A simple theoretical deduction shows that the pressure or temperature, if plotted against the mean volume of the container, is constant over a finite range of the abscissa. This result is in agreement with published experimental results for xenon, ethane and ethylene. [English translation in Soviet Physics—JETP (USA)]. R.Eisenschitz

136 ON MAYER'S IONIC SOLUTION THEORY.
H.L.Friedman.
Molecular Phys. (GB), Vol. 2, No. 1, 23-38 (Jan., 1959).

This theory, which is based upon McMillan and Mayer's cluster expansion (Abstr. 5110 of 1957; 2177, 2820 of 1958) of the grand partition function, is extended to include all of the components of the potentials of average force between sets of solute molecules or ions in the solvent at infinite dilution. The resulting cluster integral sum, which is a sum of integrals over an infinite number of infinite series of Mayer prototype graphs, is transformed into the sum of a single infinite series of integrals on graphs involving new types of bonds. These bonds are defined in a way first suggested by Meeron (Abstr. 300 of 1945; 2424 of 1951). There results a compact expression for the cluster integral sum. [See also Abstr. 7841 of 1959; an erratum to the latter is given in Molecular Phys., Vol. 2, No. 4, 436 (Oct., 1959).]

137 IONIC INTERACTIONS IN SOLUTIONS OF ELECTROLYTES AS STUDIED BY ULTRA-VIOLET SPECTROSCOPY. T.R.Griffiths and M.C.R.Symons.
Molecular Phys. (GB), Vol. 3, No. 1, 90-102 (Jan., 1960).

Spectrophotometric evidence for the formation of contact ion-pairs in solutions of tetra-alkylammonium iodides in certain solvents of poor ionsolvating power, such as carbon tetrachloride, is presented. Since the band ascribed to contact ion-pairs is not detected for solutions in other solvents, such as chloroform, it is concluded that the ion-pairs detectable by other techniques in such solvents are separated by solvent molecules.

138 APPLICATION OF THE PRINCIPLE OF CORRESPONDING STATES TO THE VISCOSITY AND DIFFUSION OF PURE LIQUIDS AND MIXTURES.

G.Thomaes and J.van Itterbeek.
Molecular Phys. (GB), Vol. 2, No. 4, 372-8 (Oct., 1959).

An attempt is made to establish a theorem of corresponding states for the viscosity and diffusion of pure liquids and solutions, based on Prigogine's theory of solutions [Molecular Theory of Solutions. Amsterdam: North-Holland Publishing Company (1957)]. The agreement between theory and the little available experimental data is satisfactory.

139 INTERPRETATION OF ION MOBILITY MEASUREMENTS IN ARGON AND HELIUM LIQUIDS.

D.W.Swan.
Proc. Phys. Soc. (GB), Vol. 76, Pt 1, 36-48 (July, 1960).

Previous interpretations of ion-mobility measurements in liquefied argon and helium in terms of gas-kinetic theory showed that these liquids do not behave as compressed gases. A more detailed analysis of the total ion energy shows that in some instances the results were incorrectly interpreted, while in others it would appear that impurities caused the apparent failure of theory. The re-interpretation indicates that kinetic theory is applicable to these liquids, and that the collision cross-sections for ions in argon and helium I are very nearly the same in both the gaseous and liquid phases. Polarization attraction is shown to be of great importance. In liquid helium II it is necessary to consider quantum effects, but the experimental data can still be explained adequately by gas kinetic equations.

140 SOUND VELOCITY MEASUREMENTS IN LIQUID ARGON UNDER HIGH PRESSURE.

A.van Itterbeek, W.Grevendonk, W.van Dael and G.Forrez.
Physica (Netherlands), Vol. 25, No. 12, 1255-8 (Dec., 1959).

Using an acoustical interferometer, measurements were made under pressures of up to 75 kg/cm^2 in the temperature range 84° K-90.3° K. The compressibility coefficient and the ratio of specific heats are calculated as a function of pressure at 90.3° K. For this calculation, use was made of the experimental data relating the variation of density to pressure.

141 A STUDY OF SOLUTE DIFFUSION IN LIQUID TIN.

C.H.Ma and R.A.Swalin.
Acta metallurgica (Internat.), Vol. 8, No. 6, 388-95 (June, 1960).

The diffusion of aluminium, zinc, silver, copper and nickel in liquid tin has been investigated by the capillary-reservoir technique in a temperature range from 240 to 480°C. All of the solutes investigated were present in dilute solutions ranging from 0.2 to 0.7 wt%. The solutes were chosen so as to cover a range of relative partial molal enthalpies from large positive values to large negative values. On the basis of the self-diffusion of tin, it is found that the ratios of D(solute) to D(self) are 4.70, 1.90, 1.57, 1.15 and 1.10, respectively for aluminium, zinc, silver, copper and nickel within ±15-20% error. Diffusion coefficients of copper and nickel can be considered to be identical with that of tin within experimental error. The Stokes—Einstein and Eyring equations which consider only the factor of atom size, do not predict accurately the relative order of diffusion coefficients amongst the solutes. They do, however, predict the order of magnitude of the diffusion constant. On the basis of fluctuation theory, it is expected that those solutes which have a large positive relative partial molal enthalpy diffuse considerably faster than those solutes which have a large negative relative partial molal enthalpy since there is a much higher probability of significant density fluctuations occurring in the vicinity of the solute atoms in the former case. The data appear to be in agreement with this conclusion. Unfortunately no quantitative comparison is feasible at the present time because of the lack of potential energy versus distance data for solute-solvent neighbours in solution. It is further proposed that in dilute solutions, the diffusion coefficient of a solute approaches that of the solvent if the solute has a zero or large negative relative partial molal enthalpy in the solvent.

142 THERMODYNAMICAL INVESTIGATIONS ON METALLIC SYSTEMS. XI. DETERMINATION OF THE MISCIBILITY GAP BY CALCULATION FROM THE THERMODYNAMICAL FUNCTIONS FOR THE TERNARY SYSTEM Zn—Sn—Bi.

L.Oleari and M.Fiorani.
Ricerca sci. (Italy), Vol. 29, No. 10, 2219-29 (Oct., 1959). In Italian.

For Pt X, see ibid., Vol. 27, No. 12, 3614 (Dec., 1957). The partial molar thermodynamical functions of Zn in the ternary system were determined by e.m.f. measurements along four pseudo-binary Zn—Bi systems. From these, the integral and partial molar quantities for the three components were computed by an approximate method, and hence the contours of the miscibility gap were worked out at 450, 500 and 550°C by an extension of Schatchard's method (1940). L.Pincherle

143 INVESTIGATION OF THERMODYNAMIC PROPERTIES OF LIQUID In—Bi ALLOYS.

N.V.Alekseev, Ya.I.Gerassimov and A.M.Evseev.
Dokl. Akad. Nauk SSSR, Vol. 134, No. 3, 618-20 (Sept. 21, 1960).
In Russian.

Presents the results of determinations of ΔH and ΔS for the system In—Bi in the temperature interval 240-300°C from the measurements of e.m.f. of the concentration cell $\mathrm{In_{liq}}\,|\,\mathrm{In^+}$ (in a melt of KCl, LiCl and $ZnCl_2$) $|\,(\mathrm{N_1In + N_2Bi})_{\mathrm{liq}}$; ΔH_{In} was found to pass from negative to positive values at a certain N_{In}. The deviations of activities from ideal values are positive for this temperature range, whereas they are negative for higher temperatures. F.Lachman

EUTECTIC COMPOSITIONS AND LIQUID IMMISCIBILITY IN CERTAIN BINARY ALLOYS. See Abstr. 21244 of 1960

144 COMMENT ON DYNAMICAL THEORY OF ELECTROSEDIMENTATION.

C.J.MacCallum.
J. chem. Phys. (USA), Vol. 33, No. 4, 1263-4 (Oct., 1960).

Supplements Prock and McConkey's paper (Abstr. 3520 of 1960). A numerical solution is given of the time dependence of the capacitance change induced in a cylinder of solution by an applied electrostatic field. It is shown that an average diffusion constant only may be obtained by measurement of time dependence alone. If the diffusion constant is separately determined for the weight average mass present the width of the mass spectrum may possibly be determined. R.G.C.Arridge

145 SCATTERING OF LIGHT IN SOLUTIONS OF QUININE SULPHATE.

M.Giurgea, C.Ghită and M.Musa.
Rev. de Physique (Roumania), Vol. 4, No. 4, 449-55 (1959).
In French.

Earlier work carried out to find if the fluorescence of certain solutions was due to molecular aggregates formed by the dissolved substance indicated that in some circumstances this could be true. An attempt is described to verify this by determining by light scattering experiments the degree of dispersion of some fluorescent substances in solution. Experimental details are given and the results presented for neutral and acid salts of quinine sulphate. The results indicate the existence of a correlation between intensity of fluorescence and degree of association. H.G.Jerrard

146 RAMAN SPECTRA OF EQUIMOLECULAR SOLUTIONS OF WATER AND ACETIC ACID.

I.Cucurezeanu.
Stud. Cercetari Fiz. (Roumania), Vol. 9, No. 2, 269-76 (1958).
In Roumanian.

147 SENSITIZATION AND PROTECTION OBSERVED IN G-VALUE AND RADIATION INDUCED LUMINESCENCE.

S.Okamura and T.Manabe.
Mem. Fac. Engng. Kyoto Univ. (Japan), Vol. 21, Pt 3, 294-311 (July, 1959).

From both the G-values and fluorescence intensity in organic two component systems, the direction of the excitation energy transfer may be determined. Agreement between the directions determined by these two methods, i.e. G-value and fluorescence intensity is found to hold in most cases. But in the benzene—methyl acetate system, the directions determined are found to be opposite to each other. It is found that the carbon—carbon double bound in vinyl monomers is able to quench the excited state of the saturated or unsaturated hydrocarbons. It is concluded that with some exceptions the excitation energy is transferred from saturated hydrocarbons to unsaturated hydrocarbons, vinyl monomers and halogenated compounds, and from unsaturated hydrocarbons to vinyl monomers and halogenated compounds, and also from vinyl monomers to halogenated compounds. Some excitation energy transfer schemes are discussed quantitatively in comparison with experimental results, and some rate constants are determined. It is found that a constant referring to the energy transfer obtained in fluorescence experiments is much larger than that obtained in radical formation.

148 ON THE PHOTOLUMINESCENCE OF FLUORESCEIN IN METHYL POLYMETHACRYLATE.

J.Grzywacz, A.Kawski and Z.Polacki.

Bull. Acad. Polon. Sci. Ser. Sci. math. astron. phys. (Poland), Vol. 8, No. 3, 187-90 (1960).

Solid polymerized solutions of fluorescein in methyl metha-rylate were used, with alcohol addition to increase dye solubility. The emission anisotropy spectrum is the same for dye concentra-ions between 6.6 × 10^{-3} and 5.4 × 10^{-5} g/cm^3, and the yield of luorescence to 4600A excitation is also constant. Since absorption nd emission maxima for these solutions are more widely separated n the spectrum than for glycerol or water solutions, concentration epolarization probably occurs at much higher concentrations in the olymerized solutions. S.T.Henderson

PERMITTIVITY AND DIELECTRIC LOSSES IN SOME POLAR UBSTANCES UNDER THE INFLUENCE OF A CONTINUOUS LECTRIC FIELD. See Abstr. 20950 of 1960.

149 STUDY OF THE MINIMUM CONDUCTIVITY AT 30-40°C OF INSULATING LIQUIDS WITH HOMOCHARGES AT NORMAL TEMPERATURE (CONTINUOUS MEAN FIELDS BELOW 2 kV/cm).

R.Guizonnier and C.Thomas.
. Phys. Radium (France), Vol. 20, Suppl. No. 12, 153A-158A (Dec., 1959). In French.

Some insulating liquids (producing homocharges) have a minimum conductivity towards 30°-40°C. Past this minimum the liquid beys the law of the liquids producing heterocharges (W = 0.41 eV):

$$i_0 = A e^{-W/kT}.$$

The minimum disappears when the electrodes are varnished or reated with an oxidized mixture. The phenomena can be explained y the presence of water in the insulating liquid.

150 ELECTRICAL RESISTANCE IN LIQUID METALS AND THE CHANGE ON MELTING.

D.K.C.Macdonald.
hil. Mag. (GB) (Eighth Ser.), Vol. 4, 1283-6 (Nov., 1959).

Experiments on the variation with temperature of the resistance liquid Rb at constant volume indicate an apparent additional residual resistance amounting to about one quarter of the total change of esistance on melting. Therefore, in considering the electrical esistance of liquids, the spatial disorder must be taken into account, esides the reduction in the characteristic temperature. L.Pincherle

151 SOME REMARKS ON THE CONDUCTION CURRENT IN INSULATING LIQUIDS.

K.Sugita, T.Satō and Y.Toriyama.
Brit. J. appl. Phys., Vol. 11, No. 12, 539-42 (Dec., 1960).

The influence of gases, absorbed in liquids and adsorbed on the surface of electrodes, upon the current conduction in insulating liquids was investigated. At field strengths up to 10^5 V/cm, the current depends upon the gases adsorbed on the electrode surfaces as well as on those absorbed in the liquid. Based upon the experimental results obtained in uniform and non-uniform fields, the hypothesis that carriers are supplied from the anode in liquids is discussed in relation to the gas-adsorbing power of the metals used as electrodes. It is believed that if the electrodes are not degassed, the conduction currents are governed not only by negative carriers from the cathode but also by positive ones formed at the anode.

152 MAGNETIC SUSCEPTIBILITY OF LIQUID ALLOYS OF COPPER WITH COBALT, IRON, MANGANESE, AND CHROMIUM.

Y.Nakagawa.
. Phys. Soc. Japan, Vol. 14, No. 10, 1372-9 (Oct., 1959).

A systematic investigation was made at temperatures up to 600°C. The molten metals are miscible in all proportions except or the Cu—Cr system. The susceptibilities of the Cu—Co and Cu—Fe alloys follow the Curie—Weiss law. The Curie constant is oughly proportional to the concentration of Co or Fe. The paramagnetic Curie temperature for the Cu—Co system rises monoton-usly with the concentration of Co, while that for the Cu—Fe system hows a maximum at an intermediate composition. In the Cu—Mn nd Cu—Cr systems, only the Cu-rich alloys show the Curie—Weiss aramagnetism, while the alloys containing more than 50% Mn or more than 5% Cr show rather temperature-independent paramagnetism.

LINE SHAPES OF ELECTRON PARAMAGNETIC RESONANCE IGNALS PRODUCED BY POWDERS, GLASSES, AND VISCOUS LIQUIDS. See Abstr. 21219 of 1960

153 DYNAMIC POLARIZATION OF NUCLEI AND MOLECULAR DIFFUSION.

J.L.Motchane and J. Uebersfeld.
C.R. Acad. Sci. (France), Vol. 251, No. 1, 73-5 (July 4, 1960).
In French.

It is argued that molecular diffusion can be employed to account for dynamic nuclear polarization phenomena in liquids surrounding a porous paramagnetic substance. A simple molecular model is proposed, and it is shown on the basis of this model that molecular diffusion effects are responsible for a considerable decrease in the expected amplification factor of the nuclear polarization. P.M.Parker

154 CHEMICAL SHIFTS OF THALLIUM RESONANCE SPECTRA IN SOLUTIONS OF THALLOUS SALTS.

R.Freeman, R.P.H.Gasser, R.E.Richards and D.H.Wheeler.
Molecular Phys. (GB), Vol. 2, No. 1, 75-84 (Jan., 1959).

Chemical shifts of the thallium nuclear resonance were measured in solutions of thallous hydroxide, fluoride, acetate, formate, nitrate, and perchlorate of varying concentrations and in the presence of added substances. At low concentrations the chemical shift varies non-linearly with concentration of anion and can be correlated with the formation of ion-pairs. In stronger solutions the variation of chemical shift becomes linear, and is attributed to interactions between the ion-pairs and the added substances.

155 THALLIUM NUCLEAR RESONANCE SPECTRA. II.

R.Freeman, R.P.H.Gasser and R.E.Richards.
Molecular Phys. (GB), Vol. 2, No. 3, 301-8 (July, 1959).

Chemical shifts are recorded for the thallium resonance of Tl^{203} and Tl^{205} in a number of thallium compounds in the solid state and in aqueous solutions. Different chemical shifts are found for Tl^+, $(TlCl_4)^-$ $(TlCl_6)^{3-}$. Solid Tl_2Cl_3 shows two thallium resonances with intensities in the ratio 3 : 1, consistent with the formula $Tl_3(TlCl_6)$. Hydrated thallic chloride in the solid state shows three thallium resonances which may be due to the presence of $[Tl(H_2O)_x]^{3+}$ $(TlCl_4)^-$ and $(TlCl_6)^{3-}$. The chemical shifts of the thallium resonance in aqueous thallic chloride and bromide solutions in the presence of added halides are consistent with the stepwise formation of complex ions. The second moments of the resonances of the two thallium isotopes in solid compounds shows that there is spin—spin coupling between the thallium isotopes, and a weak coupling in some cases between thallium nuclei and the nuclei of anions.

156 ION-PAIR FORMATION IN THALLOUS SOLUTIONS. III.

R.P.H.Gasser and R.E.Richards.
Molecular Phys. (GB), Vol. 2, No. 4, 357-61 (Oct., 1959).

Chemical shifts and spin—lattice relaxation times were measared for the thallium resonance in solutions of thallous salts containing ferricyanide ions and citrate ions. The results provide strong evidence that the ion-pairs which are formed in these strong solutions are of a predominantly electrostatic character.

157 PROTON MAGNETIC RELAXATION IN SOLUTIONS OF A MANGANOUS SALT.

H.Yoshioka and T.Fujita.
J. Phys. Soc. Japan, Vol. 14, No. 12, 1717-24 (Dec., 1959).

The spin-lattice relaxation time T_1 and the spin phase-memory time T_2 of protons in methanol solutions containing manganous ions were studied by use of the coherent-pulse technique. The relaxation curves were resolved into two components: a short-time component corresponding to hydroxyl-group protons and a long-time component corresponding to methyl-group protons. The T_1/T_2 ratio for methyl group protons is considerably larger than unity. This indicates a finite density of unpaired electrons of the methyl group protons of alcohol ligands around a manganous ion. Similar studies are reported for a mixture of methanol and water containing manganous ions.

MECHANICS OF GASES

158 THE VARIATION IN THE VISCOSITY OF CERTAIN MIXTURES OF GASES AND OXYGEN UNDER THE INFLUENCE OF A MAGNETIC FIELD.

I.Ursu.
Stud. Cercetari Fiz. (Roumania), Vol. 9, No. 2, 195-202 (1958).
In Roumanian.

Oxygen—hydrogen, air—hydrogen, oxygen—methane and air—methane mixture, flowing through cylindrical capillaries and porous materials, under a constant magnetic field were studied. It is shown that the magnetic variation of the viscosity of these mixtures is a function of the diameter of the capillary tubes and the mean granulation of the porous materials. It is also shown that the effect of hydrogen is to check the phenomena. The amplification produced by methane on the magnetic variation of the viscosity of oxygen was studied. The influence of certain other gases on the effect of the magnetic variation of the viscosity of oxygen, and the possibility of using this effect to analyse by a magnetic method was also studied.

159 XENON—KRYPTON, XENON—ARGON, XENON—NEON AND XENON—HELIUM VISCOSITY AND THERMAL CONDUCTIVITY OF BINARY GAS MIXTURES. E.Thornton.
Proc. Phys. Soc. (GB), Vol. 76, Pt 1, 104-12 (July, 1960).

The coefficients of viscosity (η) and thermal conductivity (λ) of binary mixtures of xenon with krypton, argon, neon and helium were determined experimentally over the full range of composition of each mixture at a pressure of 70 cm of mercury and at a temperature in the range 18.0 to 18.3°C. Values of the dimensionless quantity $f = \lambda/\eta c_V$ (where c_V is the specific heat at constant volume) were obtained for each mixture. The experimental values were compared with theoretical values based on the Lennard-Jones (6-12) potential of interaction between molecules, using force constants derived from viscosity data. Agreement between the experimental and theoretical results was not complete. It was suggested that the discrepancies may be due principally to deficiencies in the empirical rule recommended in the literature for determining the force constant, ϵ_{12}/k, for interactions between unlike molecules.

160 TIME OF ARRIVAL MEASUREMENTS IN LOW PRESSURE FLUID FLOW.
W.J.Guman and C.C.Cavalconte.
Rev. sci. Instrum. (USA), Vol. 31, No. 11, 1244-5 (Nov., 1960).

161 HIGH SUBSONIC FLOW PAST A WEDGE IN A TWO-DIMENSIONAL WIND TUNNEL AT ITS CHOKED STATE.
S.Morioka.
J. Phys. Soc. Japan, Vol. 14, No. 8, 1098-1101 (Aug., 1959).

The flow past a symmetrical double-wedge profile placed midway between two parallel walls is investigated. The subsonic flow field over the front half of the profile is given by the relaxation solution for a Tricomi's boundary value problem in the hodograph plane. The supersonic flow over the rear half is calculated by the method of characteristics. The results for the pressure distribution and the choking Mach number are found to agree well with Marschner's analytical results over a fairly wide range of the transonic parameter.

162 FURTHER INVESTIGATION ON THE TRANSITION OF TWO-DIMENSIONAL SEPARATED LAYER AT SUBSONIC SPEEDS. H.Sato.
J. Phys. Soc. Japan, Vol. 14, No. 12, 1797-1810 (Dec., 1959).

For previous work, see Abstr. 7203 of 1956. Experiments were made on the artificially excited transition of two-dimensional separated layers at subsonic speeds. The response characteristics of the laminar layer to the sinusoidal external disturbances were found to be in good agreement with theoretical calculations based on the Orr—Sommerfeld equation. The effect of excitation becomes maximum when the frequency of external excitation coincides with that of the naturally excited sinusoidal velocity fluctuation in the laminar layer. No remarkable abrupt turbulent bursts are found in the transition region. The waveform of velocity fluctuation changes gradually from sinusoidal to irregular patterns.

163 THEORETICAL AND EXPERIMENTAL STUDIES ON THE VORTEX-TUBE. M.Suzuki.
Sci. Pap. Inst. Phys. Chem. Res. (Japan), Vol. 54, 43-87 (March, 1960).

The vortex tube is a device which utilizes the centrifugal force produced by the vortex motion in a cylindrical tube. The gas flow is a three-dimensional flow in axial and radial directions with vortex motion, and there is no other main flow. Based on certain assumptions concerning the velocity profile, approximate analyses are attempted from the aero-dynamic, thermodynamic and acoustic standpoints; there is quantitative agreement with experimental results.

164 DEPOSITION OF LYCOPODIUM SPORES UPON GLASS SLIDES EXPOSED IN A WIND TUNNEL. C.N.Davies.
Brit. J. appl. Phys., Vol. 11, No. 12, 535-8 (Dec., 1960).

An analysis, based upon experimental data, is made of aerodynamic factors concerned in the deposition of "Lycopodium" spores upon glass microscope slides exposed at various angles in a wind tunnel. Gravity controls deposition on horizontal slides only at low wind speeds; with increasing speed impingement upon the leading edge of a microscope slide prevents deposition from taking place o the upper surface. At sufficiently high wind velocities deposition takes place by eddy impaction, originating from turbulence in the main air stream, upon the upper and lower surfaces. Deposition o the lee side of bluff obstacles by eddy impaction is discussed.

Shock Waves

165 ON FLOW DURATION IN LOW-PRESSURE SHOCK TUBES. A.Roshko.
Phys. of Fluids (USA), Vol. 3, No. 6, 835-42 (Nov.-Dec., 1960).

The severe decrease of flow duration in shock tubes operating at low pressures, previously reported by Duff, is confirmed by experiment and by an analysis of the effects of the laminar-boundar layer behind the shock wave. The latter leads to a shock tube similarity length parameter X, which depends on the tube pressure, diameter and shock Mach number, and to a flow duration parameter T. The theoretical relation T = t(X) is determined and compared wi experimental results. From the theoretical result $T_{max} = 1$, the maximum possible flow duration τ_m in a shock tube is determined; it increases linearly with the initial pressure and the square of the tub diameter and decreases strongly with shock Mach number.

166 FLOW BEHIND SHOCK WAVES IN CONDUCTING GASE R.P.Kanwal.
Proc. Roy. Soc. A (GB), Vol. 257, 263-8 (Sept. 6, 1960).

It is proved that in addition to generating vorticity, the shock waves in conducting gases generate electric current also. Secondly it is shown that the expression for vorticity in conducting gases, in contrast to non-conducting gases, depends on the thermodynamic behaviour of the fluid. Furthermore, an interesting relation between the normal components of the vorticity and current density is discovered.

167 THE STRUCTURE OF SHOCK FRONTS IN VARIOUS GASES. W.H.Andersen and D.F.Hornig.
Molecular Phys. (GB), Vol. 2, No. 1, 49-63 (Jan., 1959).

The optical reflectivity of shock fronts in A, N_2, O_2, CO, CO_2, N_2O, CH_4, Cl_2 and HCl was studied. The thickness of shock fronts in A up to the Mach number M = 1.55 is in agreement with the theor of Gilbarg and Paolucci (1953). The rotational relaxation time is about 5.5 collisions in N_2 and equal to or less than that in the other gases. However, for stronger shocks N_2 does not appear to reach rotational equilibrium in the shock front and a qualitative theoretica discussion of this phenomenon is presented. In HCl there appears t be over-excitation of rotation in the shock front. There is no vibrational excitation of any of the gases.

168 GRAPHICAL ANALYSIS OF THE FORMATION OF SHOCK FRONTS IN MATERIALS.
Shoi-Yean Hwang and N.Davids.
J. Mech. Phys. Solids (GB), Vol. 8, No. 1, 52-65 (Jan., 1960).

Contour-plotting methods are applied to non-linear materials with a two-straight-line stress—strain relation, such as certain types of rubber or foam plastic. The multiple scabbing phenomeno of materials due to tensile reflection from a free boundary is analysed and presented graphically. General rules governing the structure of the characteristics field are obtained.

169 SOME UNEXPECTED RESULTS OF SHOCK-HEATING XENON. P.Gloersen.
Phys. of Fluids (USA), Vol. 3, No. 6, 857-70 (Nov.-Dec., 1960).

Results from a detailed experimental study of the structure of pressure-driven incident shock waves in very pure xenon contained in a thoroughly pumped Pyrex shock tube are presented and discussed. As a result of some optical studies of the luminous structure of the shocks, the following features of the luminosity delay time were discovered: independence of the pressure in the undisturbed xenon in the range 0.75 to 4.0 mm Hg, dependence on shock velocity in a way not explainable on the basic of reasonable volume processes alone, and dependence on shock tube diameter. The visible luminosity from the shock was found to terminate well in advance of the measured position of the xenon-driver interface. This is indicative of severe radiation cooling. The visible luminos was also found to be profoundly altered by the addition of impuritie either in the xenon itself or in the driver. The spectrum of the layed luminosity in the region from 3000 to 10 000 A was studied th an electronic-recording time-resolving spectrometer and und to consist of xenon atom lines superimposed on a strong ntinuum. The continuum may reasonably be attributed to ssociative transitions from bound excited states of the Xe_2 olecule related to the xenon atom levels $7p_{KJ}$ and above to un-und Xe_2 states related to the atomic levels of $6s_{11}$ and $6s_{12}$. sitive electrical signals, observed during the passage of the ock through external metal rings, are attributed to ejection of ectrons from the shock tube walls by photoelectric action and/or etastable atoms. In addition, two different types of electrical ecursor were observed. The first was observed under the usual nditions, namely, that the shock was sufficiently strong to cause e delayed luminosity. The second was observed in some experi-ents in which the shock was too weak to cause the delayed lumi-sity. Both could be due to a photoelectric effect on the shock tube lls, but the precursor observed in the absence of the delayed minosity may be also due to diffusion of electrons ahead of the ock front. The present experiments strongly indicate that shock be experiments of others may need reinterpretation.

170 HYDRODYNAMIC ASPECTS OF SHOCK TUBE SPECTROSCOPY. O.Laporte and T.D.Wilkerson.

Opt. Soc. Amer., Vol. 50, No. 12, 1293-9 (Dec., 1960).

Time-resolved spectroscopic observations with the shock tube e described. Emission spectra were recorded for the high-mperature gas behind the shock reflected from the closed end of e tube. Simultaneous observations were made of the hydrodynamic riables. The state of the emitting gas is predicted by hydro-namic theory and correlated with the observed spectrum. Devi-ions from ideal theory caused by viscosity and heat conduction are cognized, and their influence upon pressure and temperature is praised by direct measurement.

GASEOUS STATE

171 KINETIC THEORY OF MODERATELY DENSE GASES: RIGID SPHERE LIMIT. R.F.Snider and C.F.Curtiss.

's. of Fluids (USA), Vol. 3, No. 6, 903-4 (Nov.-Dec., 1960).

The rigid sphere limiting forms of the expressions for the st-order density corrections to the transport coefficients viously derived (Abstr. 2875 of 1958) from the modified tzmann equation of Green and Bogoliubov and re-examined. It shown that in this limit these expressions approach the classic ults of Enskog.

GAS-KINETIC THEORY OF LIQUID ARGON AND HELIUM.

e Abstr. 139

172 ON THE RELATION BETWEEN TOTAL AND PARTIAL PRESSURE OF GAS MIXTURE.

Sugawara, T.Sato and T.Minamiyama.

em. Fac. Engng Kyoto Univ. (Japan), Vol. 21, Pt 3, 247-59 (July, 59).

It may be inadequate, in general, to apply Dalton's law to an im-rfect gas mixture. In this paper, the total pressure of an imperfect s mixture is considered from the view point of statistical mechanics. mely, by expressing the equation of state in the virial expansion rm, the total pressure of a gas mixture was determined analytically using the second and the third virial coefficients calculated from e values for each component gas. As an example, the second and rd virial coefficients of air were calculated by two methods and mpared with each other as well as with other values which were termined directly from experimental data with air. From the merical calculations for air and also for a water—mercury vapour xture, it is shown that there is some difference between the total essure calculated by the above method and the value calculated from lton's law, this difference increasing with the degree of imperfect-ss of the gas mixture.

173 DIFFUSION COEFFICIENTS OF GASES FROM THE RATE OF APPROACH TO THE STEADY STATE IN IERMAL DIFFUSION. S.C.Saxena and E.A.Mason.

olecular Phys. (GB), Vol. 2, No. 3, 264-70 (July, 1959).

The rate of approach to the steady state in a convection-free o-bulb thermal diffusion experiment is treated in a more rigorous anner than previously available, in order that reliable ordinary fusion coefficients may be derived from thermal diffusion meas-ements. The final results are of the same form as in the original nplified Jones and Furry treatment (Abstr. 1273 of 1947), but the parameters are now interpreted somewhat differently and a new correction term appears. Application to Nettley's measurements on H_2—N_2 mixtures (Abstr. 116 of 1955) removes an apparent discrepancy with the kinetic theory prediction of the composition dependence of the diffusion coefficient for this system.

174 THERMAL DIFFUSION AND THE APPROACH TO THE STEADY STATE IN GASES. II.

S.C.Saxena and E.A.Mason.

Molecular Phys. (GB), Vol. 2, No. 4, 379-96 (Oct., 1959).

The theory of the rate of approach to the steady state in thermal diffusion (see preceding abstract) is tested experimentally on the systems He—A, He—CO_2, H_2—CO_2, and D_2—CO_2 over a temperature range of about −78° to 325°C. The course of the diffusion was followed by means of the radioactive tracers A^{37} and $C^{14}O_2$. The theory appears to be verified, and the results are used to calculate ordinary diffusion coefficients, which are in reasonable accord with previous measurements by other techniques. The thermal diffusion factors, which are obtained from the same measurements, also appear to have reasonable accuracy. The experimental method therefore appears to have promise as a sensitive method for the determination of forces between unlike molecules.

175 SOLUTIONS OF CONCENTRATION-DEPENDENT DIFFUSION EQUATION. R.Paul.

Phys. of Fluids (USA), Vol. 3, No. 6, 905-7 (Nov.-Dec., 1960).

The concentration of a gas in a chamber of Ney and Armistead type, as a function of time, has been calculated for two simple cases of concentration dependence of the diffusion coefficient (i) $D = D_0(1 + \alpha c)$, and (ii) $D = D_0[1 + \alpha c/(1 + c)]$. The correction due to the nonattainment of a quasi-stationary state has also been calculated.

176 KIRKENDALL EFFECT IN GASEOUS DIFFUSION. K.P.McCarty and F.A.Mason.

Phys. of Fluids (USA), Vol. 3, No. 6, 908-21 (Nov.-Dec., 1960).

An experiment is described which is the analogue in gases of the well-known Kirkendall effect in solids. The experiment can also be thought of as a measurement of the pressure differences arising in a diffusing gas mixture. Seven gas mixtures were measured at 30°C and over a maximum pressure range of about 0.2 to 1.7 atm as follows: H_2—D_2, CO_2—C_3H_8, He—A. He—CO_2, H_2—CO_2, D_2—CO_2, and H_2—(H_2 + CO_2 mixture). The results are discussed in terms of the usual phenomenological theory of the Kirkendall effect and the rigorous kinetic theory of gases. The phenomenological theory is shown to be incorrect, but the kinetic theory is capable of accounting for all the effects observed, usually quantitatively. The results can be used to determine gaseous diffusion coefficients from the observed marker motion, and the diffusion coefficients obtained are in reasonable agreement with those obtained by other methods.

177 THEORETICAL STUDY OF THE ELECTRON DRIFT VELOCITY IN BINARY GAS MIXTURES WITH APPLICATIONS TO A—CO_2 AND A—N_2 MIXTURES.

M.A.Uman and G.Warfield.

Phys. Rev. (USA), Vol. 120, No. 5, 1542-50 (Dec. 1, 1960).

Starting with the Boltzmann equation, a theoretical expression is developed for the electron drift velocity in a binary gas mixture. The theory reduces to that of Morse, Allis, and Lamar in the absence of one of the gases. The theory is applied to pure argon and to mixtures of A—0.1% CO_2, A—0.16% CO_2, A—1.0% CO_2, A—0.1% N_2, A—0.5% N_2, and A—1.0% N_2. The theoretical drift velocity curves for A—CO_2 are in close agreement with experimental data, whereas the A—N_2 curves differ from experimental data. Possible reasons for this discrepancy are discussed.

178 VAPOR PRESSURE DATA FOR SOME COMMON GASES. R.E.Honig and H.O.Hook.

RCA Rev. (USA), Vol. 21, No. 3, 360-8 (Sept., 1960).

For 26 gaseous compounds that are frequently encountered in ultra-high-vacuum or low-temperature work, the following data have been selected, evaluated, tabulated, and plotted: vapour pressures; transition, melting, and boiling points; and their associated energies. Vapour pressures have been plotted as log p (mm Hg or Torr) versus log T(°K). This collection contains data available before April, 1960.

179 AN UPPER LIMIT FOR THE VAPOUR PRESSURE OF BISMUTH (ThC) AT ROOM TEMPERATURE.

J.S.Ausländer, V.Labău and S.Meitert.

Stud. Cercetari Fiz. (Roumania), Vol. 10, No. 2, 229-34 (1959).

In Roumanian.

The vapour pressure of Bi (ThC) at room temperature was determined by a photographic method previously described [Proceedings of the International Conference on the Peaceful Uses of Atomic Energy, Geneva, Vol. 7, 389 (1955)], as approximately 10^{-17} mm Hg. It is certainly smaller than 6×10^{-17} mm Hg.

180 ACOUSTIC ABSORPTION IN CO_2–A MIXTURES. H.O.Kneser and H.Roesler.
Acustica (Internat.), Vol. 9, 224-6 (1959) [=Akust. Beihefte, No. 1 (1959)]. In German.

Measurements of the sound absorption in mixtures with up to 90% argon (at frequencies between 1 and 5 kc/s and pressures between 20 and 700 torr) show an 8-fold increase in the CO_2 relaxation time. The relaxation velocity does not change linearly with argon concentration.

MEASUREMENT OF THE VELOCITY OF ACOUSTIC WAVES IN SATURATED STEAM. See Abstr. 201

181 THE FLUORESCENCE AND EXCITATION SPECTRA OF ANTHRACENE VAPOUR AT LOW PRESSURES.
B.Stevens and E.Hutton.
Molecular Phys (GB), Vol. 3, No. 1, 71-8 (Jan., 1960).

The dependence of fluorescence intensity on the wavelength of exciting radiation was recorded for anthracene vapour at 0.09 mm and 170°C over the range 230-366 mμ. It is shown that whereas the photon cascade theory cannot account for the much higher intensity excited in the 250 mμ band than excited in the band at 363 mμ, this behaviour is precisely that expected if the fluorescent state is populated by internal conversion following excitation in the short-wave band. Since the excited molecules are collisionally unperturbed under these conditions, the fluorescence spectrum exhibits a marked dependence on the wavelength of exciting radiation; an increase in the energy of the absorbed quantum produces an appreciable red-shift and loss of vibrational structure.

182 THE MAGNETIC SUSCEPTIBILITY OF GASES. J.Joussot-Dubien.
J. Chim. phys. (France), Vol. 57, No. 9, 734-44 (Sept., 1960). In French.

Review giving descriptions of all principal types of apparatus that have been used, and tabulating a large number of experimental and theoretical values that have been reported in the literature. 75 references. J.Hawgood

VACUUM PHYSICS

183 FURTHER EXPERIENCES WITH ALUMINIUM WIRE SEALS FOR BAKEABLE VACUUM SYSTEMS.
L.Elsworth, L.Holland and L.Laurenson.
J. sci. Instrum. (GB), Vol. 37, No. 12, 449-51 (Dec., 1960).

The use of aluminium cemented seals in vacuum systems has been further investigated to find the effect of the flange surface finish on the adhesion of the aluminium joint and the performance of such seals in bakeable apparatus. Aluminium wire clamped between stainless-steel flanges and baked at 300°C formed more adherent joints as the surface finish was decreased from 50 to 10 μin. (average height of asperities). The aluminium joint would not cold weld with a force of 4 tons per inch of 20 s.w.g. wire using flanges with a surface finish of 10 μin., and the flanges were indented by the wire. With constant surface finishes, the strength of the aluminium joint was directly proportional to the baking temperature above a forming temperature (250°C at 10 μin.) and was greatest when the aluminium wire was perpendicular to the direction of the machining marks. Seals made between flanges with a 10 μin. finish had an adhesion strength of 354 lb/in. of wire after forming with a force of 5000 lb per inch of wire and baking at 400°C. Vacuum seals using a total length of 9 ft of wire were successfully employed in a stainless-steel vacuum plant with a 28 litre volume chamber. The plant was exhausted by an oil diffusion pump (baffled speed 40 l./s) with a liquid nitrogen trap and gave an ultimate pressure of 7×10^{-10} mm of mercury, and 10^{-10} mm of mercury using a titanium evaporated getter. The seals had to be uniformly heated to avoid unequal expansion breaking the "cemented" joints.

184 PRODUCTION OF THIN FILMS BY THERMAL EVAPORATION. P.Tomaš.
Period. math.-phys. astron. (Yugoslavia), Vol. 15, No. 2, 119-31 (1960).

The pumping system, electrical supply and evaporation chambers of several Yugoslav vacuum evaporation units are described. A discussion is given of the thermodynamic relations between the evaporation rate and the residual gas pressure, the vapour pressure of the evaporating material, its molecular weight and the temperatur of the heater. Techniques for cleaning a target and for the control o its thickness are described. Some other experiences with the evapo tion of thin films are reported.

VACUUM SYSTEM OF THE SACLAY PROTON-SYNCHROTRON See Abstr. 350

VIBRATIONS . ELASTIC WAVES

(See also Shock Waves)

185 GENERAL EXPRESSIONS FOR THE BOUNDARY CONDITIONS AND THE DIFFERENTIAL EQUATION OF EQUILIBRIUM AND VIBRATION OF AN ANISOTROPIC NON-HOMOGENEOUS PLATE. Z.Mazurkiewicz.
Bull. Acad. Polon. Sci. Ser. Sci. tech. (Poland), Vol. 7, No. 9, 519-30 (1959).

LATERAL BENDING VIBRATIONS OF AN INCOMPLETELY FLEXIBLE STRING. See Abstr. 4

186 CALCULATION OF THE FLEXURAL VIBRATIONS OF SQUARE CRYSTAL PLATES. K.Schuster and H.Vosahl
Acustica (Internat.), Vol. 9, 265-9 (1959) [= Akust. Beihefte, No. 1 (1959)]. In German.

The frequency of the natural vibration, fundamental and first overtone, of square crystal plates as used in special crystal systems and wedge sections is calculated according to the method of Ritz under the assumption that the two diameters parallel to the edges are nodal lines. The calculation is confirmed by experimental measurements.

187 ELASTIC VIBRATIONS OF QUARTZ PLATES IN STATIONARY ELECTRIC FIELDS. H.H.Pfenninger.
Naturwissenschaften (Germany), Vol. 47, No. 12, 275 (1960). In German.

The vibrations, of frequencies 5 to 100 kc/s and sometimes audible as a whistle, were set up in quartz plates cut at right angles to the optic axis during electrolysis in an inert gas. The presence of the vibrations depended on the electrodes used. The frequency was not affected by the temperature or field strength, but the amplitude of vibration increased with the field. The presence of the vibrations can be explained as a resonance effect. S.Weintrou

188 EXPERIMENTS WITH VIBRATING SOAP FILMS. L.Bergmann.
Acustica (Internat), Vol. 9, 155-90 (1959), [= Akust. Beihefte, No.1, (1959)]. In German.

An apparatus is described for demonstrating the modes of vibration of soap films of various shapes (including films shaped as violin bodies.

189 IMPROVEMENT TO THE THEORY OF THE FLOATING FLOOR. L.Cremer and M.Heckl.
Acustica (Internat.), Vol. 9, 200-10 (1959), [=Akust. Beihefte, No. 1, (1959)]. In German.

The simple theory of the floating floor considers no side boundaries and neglects the possibility of lateral coupling by the elastic interlayer. The theory is improved by introducing the propagation of cylindrical waves in this layer. This concept results in a change of the "stiffness" of the interlayer which can be observe in practice. Only when the finite size and the boundary conditions o the ceiling and the boundary conditions of the floating floor (which are different from those of the ceiling) are considered, can the deviations of the experimental results from the simple theory be explained.

190 NOTE ON THE FORCED TORSIONAL VIBRATION OF CYLINDER HAVING PERIODIC SHEARING FORCES ALONG A RING ON THE CURVED SURFACE. A.K.Mitra.
Indian J. theor. Phys., Vol. 7, No. 1, 1-4 (March, 1959).

This brief note deals with the investigation of the forced vibration of a cylinder as a result of a shearing stress applied along the circumference of a circle on the surface of the cylinder at a certain height from the lower, fixed end. Solutions are obtained (1) when both ends are fixed and (2) when only one end is fixed.

191 ON THE WORK DONE DURING BOWING.
C.Dutta.
ian J. theor. Phys., Vol. 7, No. 1, 5-15 (March, 1959).

The work done by the bow during forward motion of the string
d also the work done on the bow during its backward motion are
parately calculated for any velocity of bowing. As the works done
the two cases are equal for maintained vibration it is shown that
bowing pressure is constant during forward and backward motion
the string.

192 RAYLEIGH WAVE DISPERSION FOR A SINGLE LAYER ON AN ELASTIC HALF SPACE.
A.Bolt and J.C.Butcher.
stral. J. Phys., Vol. 13, No. 3, 498-504 (Sept., 1960).

Numerical solutions of the period equation for Rayleigh waves
a single surface layer were calculated using the SILLIAC com-
ter. Values of the phase and group velocities for both the funda-
ental and first higher mode were tabulated against period for
even models. These related models allow a sensitivity analysis of
effect of variation in the seismic parameters.

193 ON THE INTERACTION BETWEEN PLATE BENDING WAVES AND THEIR RADIATION LOAD.
Kurtze and R.H.Bolt.
ustica (Internat.), Vol. 9, 238-42 (1959), [= Akust. Beihefte, No. 1,
959)].

A specially defined impedance is used to calulate the speed of
xural waves in a plate loaded with a medium of finite or infinite
tent. There is no (coincidence) frequency at which the flexural
ve speed in a loaded plate can exactly equal the speed of sound
the surrounding medium; this restriction applies not only to an
finite medium but also to all modes of propagation in a medium of
ite extent. The plate-load interaction can shift the flexural wave
eed significantly in the regions of "coincidence", as is shown in
o examples.

194 INVESTIGATIONS ON PERIODIC WAVES, OF EXPONENTIAL AND COMPLEX NEAR-FIELDS, IN
OUNDED SOLIDS. K.Tamm and O.Weis.
custica (Internat.), Vol. 9, 275-88 (1959). [= Akust. Beihefte, No. 1,
959)]. In German.

The boundary conditions for the complete elastic equations
scribing the vibrations of a bounded solid cannot be fulfilled by
suming periodic waves only, but waves with complex and real
opagation constants are required in addition. After characterizing
e vibration problems of this kind, a discussion of all wave-forms
curring in an infinitely extended homogenous, non-dissipative
ate is given. Besides the propagation characteristics (phase
locity, damping, group velocity and energy flux) the distributions
stress and particle velocity across the section are investigated.
fferences between the sound propagation in a liquid and a solid
e pointed out.

195 THERMAL STRESS PROPAGATION IN VISCO-ELASTIC BODIES. II. W.Nowacki.
ll. Acad. Polon. Sci. Ser. Sci. tech. (Poland), Vol. 7, No. 7-8,
9-67 (1959).

ACOUSTICS

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196 SOUND PROPAGATION IN LOSSY MEDIA WITH COMPLEX. SHEAR AND COMPRESSION MODULI.
Veis.
istica (Internat.), Vol. 9, No. 5, 387-98 (1959). In German.

Wave propagation in an infinitely extended plate and in a liquid
er without shear, having pressure release terminations, is investi-
ed under the assumption of complex moduli. Besides results re-
ed to attenuation and phase velocity, interesting conclusions are
ained with respect to the modes of propagation in a non-dissipa-
medium. The results of a numerical evaluation for a rubber-
stic plate are discussed in detail. It is seen that in dissipative
dia all infinity points of the phase velocity vanish, with the only
eption of the first higher antisymmetric mode in plates. With
all loss tangents the phase velocities of extensional and flexural
ves show little deviation from those of the non-dissipative
dium. For a shear loss tangent of about 0.5 a new phenomenon is
erved as a consequence of which, for instance, the extensional
ve no longer approaches the Rayleigh wave at high frequencies.

Extensional wave and first higher antisymmetric mode are then composed of just those higher modes which in the respective frequency range show the smallest attenuation in the case of smaller dissipation.

197 METHOD OF DETERMINING THE PROPAGATION PARAMETERS OF WAVE MOTION IN ACOUSTICAL MATERIAL.
W.K.R.Lippert.
Acustica (Internat.), Vol. 9, No. 6, 435-40 (1959).

A theoretical investigation is presented on a method of determining the propagation parameters of one-dimensional wave motion in a homogeneous acoustical material. It is demonstrated that the wavelength, attenuation constant for unit length and the characteristic impedance of such a wave motion can be specified in terms of the characteristic reflection and transmission factors of a sample of thickness l measured in a tube with a non-reflecting output duct, and that numerical evaluations can be made mostly with the aid of common nomograms of complex hyperbolic functions. Certain properties of the method which illustrate its usefulness are discussed in detail, for example, in the particular case in which two sets of characteristic factors of sample thicknesses l and $2l$ are available.

198 THE TRANSMISSION OF SOUND THROUGH A WAKE.
E.G.Richardson.
Proc. Phys. Soc. (GB), Vol. 76, Pt 1, 25-32 (July, 1960).

Measurements are made of the signal picked up by a microphone in the ultrasonic beam launched across a fluid in a region containing the wake of a cylinder. Because of the disposition of vortices in the wake there is a difference of phase in sound rays reaching different parts of the microphone and the signal fluctuates periodically. These modulations of the ultrasonic signal are related to fluctuations in the velocity in the wake. The experiments are carried out (a) in water using a towed cylinder, (b) in air behind a cylinder fixed in a wind tunnel.

199 RELATED EXPERIMENTS WITH SOUND WAVES AND ELECTROMAGNETIC WAVES. W.E.Kock.
Acustica (Internat.), Vol. 9, 227-38 (1959) [= Akust. Beihefte, No. 1, (1959)].

Various analogues in acoustics and electromagnetic waves are described. Certain higher-order modes of airborne sound waves in tubes possess a transverse or polarized nature, and electromagnetic properties such as cut-off effects, polarization rotation, and circular polarization can be shown for these sound waves. Externally guided sound waves, similar to radio waves guided by a dielectric rod, are also discussed, as are superdirective acoustic and electromagnetic arrays, space-frequency equivalence in arrays, and experiments in wave diffraction.

200 THE ANALOGY OF ACOUSTIC AND ELECTROMAGNETIC BOUNDARY-VALUE PROBLEMS.
H.Severin.
Acustica (Internat.), Vol. 9, 270-4 (1959). [= Akust. Beihefte, No. 1 (1959)]. In German.

The conditions for the mathematical analogy of electromagnetic and corresponding acoustic boundary value problems are formulated. Examples of complete and partial analogy are given. Some scalar potential functions are compiled, which are solutions of acoustic boundary value problems and may be applied to the treatment of corresponding electromagnetic problems.

201 MEASUREMENT OF THE VELOCITY OF ACOUSTIC WAVES IN SATURATED STEAM. V.I.Avdonin.
Zh. tekh. Fiz. (USSR), Vol. 30, No. 10, 1245-50 (Oct., 1960). In Russian.

Describes an acoustic interferometer suitable for measurement of the velocity of sound in saturated and superheated steam. The measured velocity in saturated steam rose from 425 m/sec at 50° C to 506 m/sec at 210° C and then fell slightly (to 495 m/sec) at 250° C. The results were in satisfactory agreement with theoretical formulae derived assuming that the propagation of acoustic waves is accompanied by phase transitions. [English translation in: Soviet Physics—Technical Physics (USA)]. A.Tybulewicz

SOUND VELOCITY MEASUREMENTS IN LIQUID ARGON UNDER HIGH PRESSURE. See Abstr. 140

202 SOUND RADIATION FROM A POINT-EXCITED HOLLOW CYLINDER. M.Heckl.
Acustica (Internat.), Vol. 9, No. 2, 86-92 (1959). In German.

As Junger first showed (Abstr. 2279 of 1953), the radiation from cylinders depends on the mode of vibration. It is necessary in calculating the power radiated from a point-driven cylinder to know the energy distribution among the different natural frequencies. Approximation formulae are given for calculating the radiation in many cases; a formula for the mean square velocity is derived.

203 ACOUSTIC RADIATION FROM POINT-EXCITED PLATES. M.Heckl.

Acustica (Internat.), Vol. 9, No. 5, 371-80 (1959). In German.

An infinitely wide plate, set into damped flexural vibrations, radiates no sound energy if the wavelengths in the plate are smaller than those in air. If the plate is excited at a point, then the exponentially decaying "flexural-wave near-field" gives a small finite radiation, whose value is calculated. It is shown that the same relation holds for damped plates of finite size, but if the damping is small the radiation is determined by a different effect which is also calculated. The resulting formulae can be checked by experiment.

204 AN ULTRASONIC RADIATOR WITH NEAR-FIELD CORRECTION FOR THE TESTING OF MATERIALS.

K.von Haselberg and J.Krautkrämer.

Acustica (Internat.), Vol. 9, No. 5, 359-64 (1959). In German.

A transducer excited in the form of a Gauss function (a "Gauss-radiator") has a variation of sound pressure along its axis which is free from oscillations. Its polar curve is also a Gauss function, free from null points and minor lobes. The limitations in this behaviour for finite (clipped) Gauss functions is shown by practical examples. A probe for the ultrasonic testing of materials with such a transducer is useful for assessing without ambiguity the position and size of flows.

205 THE BEHAVIOUR OF BARIUM TITANATE TUBULAR OSCILLATORS WHICH RADIATE EXTERNALLY IN [THE REGION OF] RADIAL RESONANCE. R.Esche.

Acustica (Internat.), Vol. 9, 211-14 (1959) [=Akust. Beihefte, No. 1 (1959)]. In German.

The impedance curve of these transducers in the neighbourhood of radial resonance shows in external radiation an efficiency of about 90%. Their behaviour when employed in radially-symmetrical cooling systems is investigated. By sending part of the radially-emitted sound wave into an elliptical reflector, a good directional effect is obtained; one such transducer of large surface for a power of 1.6 kW (2 W/cm^2) is described.

206 GENERATION AND DETECTION OF ULTRASONIC WAVES IN SOLIDS BY SMALL BARIUM TITANATE TRANSDUCERS. T.Anzai.

Sci. Rep. Res. Insts Tohoku Univ. A (Japan), Vol. 11, No. 2, 152-60 (April, 1959).

In the present study it was clarified that barium titanate transducers, smaller in dimensions than the wavelengths of elastic waves in solids, transmit simultaneously longitudinal, shear and surface waves of ultrasonic frequencies when subjected to an electrical pulse. Directional characteristics of longitudinal and shear waves generated by small transducers in aluminium semi-cylinder were also measured by a pulse method. Experimental values show qualitative agreement with the theoretical predictions of Horono (1948), and Miller and Pursey (1954). It was made clear from the results of investigation of the propagation of elastic waves in aluminium plate that a transmitter and receiver should be placed in proper positions and directions on surface of solids when small transducers are applied for the detection of shear waves in solids.

ACOUSTIC ABSORPTION IN CO_2--A MIXTURES. See Abstr. 180

207 EXPERIMENTAL STUDY OF ACOUSTIC ABSORPTION BY PERFORATED PANELS. P.Lienard.

Acustica (Internat.), Vol. 9, No. 6, 419-30 (1959). In French.

A diagram was constructed whereby the acoustical absorption of resonant holes in perforated panels can be quickly determined. Then the absorption on full-scale monocellular fragments of these panels at normal incidence in a stationary-wave tube was experimentally studied. There is good agreement between theory and experiments for the resonance frequency, and fairly good agreement for the absorption value. Thus useful indications of the value of the acoustical resistance at the orifice can be obtained. Some tests were carried out at random incidence, first in an experimental gallery, then with real panels.

208 THE MUSICAL SOUND OF A CHINESE GONG.

M.Grützmacher and E.Wesselhöft.

Acustica (Internat.), Vol. 9, 221-3 (1959), [= Akust. Beihefte, No. 1, (1959)]. In German.

The spectrum was investigated. Because of the strong damping of higher partial tones, it is remarkably free from overtones. In contrast to a gothic bell, which has many overtones, all those with a nodal ring are missing from the gong.

209 INVESTIGATION OF BODY-VIBRATIONS IN THE CELL

F.Eggers.

Acustica (Internat.), Vol. 9, No. 6, 453-65 (1959). In German.

A method is described for the continuous capacitive scanning of amplitude and phase of the vibrations of the back and belly of a cello. Diagrams of the vibration pattern, obtained with sinusoidal electrodynamic excitation of the instrument with frequencies rangin from 82 to 869 c/s, are discussed. Analogous diagrams obtained with white noise excitation of a third-octave band-width between 64 and 1260 c/s show similar amplitude distributions. The vibratio patterns resemble those of zero order radiators at low frequencies while at higher frequencies there are more subdivisions; at low frequencies a superimposed torsional vibration of the belly is noticeable. Nodal lines were not sharply detected. A method for the determination of frequency diagrams of the mechanical impedances is also described. Diagrams of the absolute impedance values measured under different conditions at the bridge and at othe characteristic places show extreme values typical for the cello at frequencies between 90 and 300 c/s.

210 ACOUSTIC PUMP.

T.M.Dauphinee.

Research (GB), Vol. 13, No. 8, 300-3 (Aug., 1960).

A simply constructed air circulating pump powered by a loudspeaker is described. The pump has no moving parts other than the speaker cone and can operate from room temperatures to below liquid air temperatures at efficiencies equal to or better than those of conventional blowers.

Instruments and Measurements

211 CURVES OF EQUAL LOUDNESS WITH OCTAVE-FILTERED NOISE IN A DIFFUSE SOUND FIELD.

L.Cremer, G.Plenge and D.Schwarzl.

Acustica (Internat.), Vol. 9, No. 2, 65-75 (1959). In German.

After an introduction on the definition of loudness and its measurements, an apparatus for measuring curves of equal loudness with noise passed through octave filters and the method of operation are described. The behaviour of the persons taking part is discussed. The possibility of using a noise-level meter with data taken in a diffuse sound field, which show a fall of about 3 dB per octave, is also discussed.

212 THE 2-ml COUPLER AND THE HIGH FREQUENCY PERFORMANCE OF HEARING AIDS.

H.C.van Eysbergen and J.J.Groen.

Acustica (Internat.), Vol. 9, No. 5, 381-6 (1959).

The frequency characteristic of a miniature telephone receiver as measured with human test subjects differs considerably from the one measured with the intermediary of a 2 ml coupler—artificial ea The coupler curve shows a steep fall of 20 dB beyond 3000 c/s as compared with the human ear performance. The authors propose that the frequency characteristic should be recorded by means of a 0.5 ml coupler in which the 18 mm long canal has been avoided in order to obtain information on the useful frequency range of the receiver (hearing aid). The standardized 2 ml coupler curve should b recorded also for reasons of international exchange.

213 DETERMINATION OF THE FREE FIELD RESPONSE OF HEADPHONES. P.Bocker and H.Mrass.

Acustica (Internat.), Vol. 9, No. 4, 340-4 (Dec., 1959). In German.

The free-field response of an electrodynamic earphone (type Beyer DT48) for frequencies from 80 c/s to 12 kc/s was determined by two subjective methods. The monaural method gave values which in the range from 80 to 4000 c/s, were about 6.5 dB down on the binaural method. For the range from 80 to 1000 c/s it is shown that, in using this type of earphone, the monaural meth may give unreliable results.

214 DETERMINATION OF THE PRESSURE SENSITIVITY OF MICROPHONES. H.G.Diestel.

ıstica (Internat.), Vol. 9, No. 5, 398-403 (1959). In German.
The sensitivity was determined over a wide frequency range,
ing the impedances of the microphones as well as the cavities of
coupling devices into account. An experimental set-up for the
asurement of acoustical impedances is described. As an example,
acoustic data of a condenser microphone are given. The calibra-
n of microphones in an air-filled coupler in the frequency range
m 30 to 15 000 c/s is described.

oise . Architectural Acoustics

215 THE [SUBJECTIVE] LOUDNESS OF NOISE FROM HEAVY VEHICLES. H.J.Rademacher.

ustica (Internat.), Vol. 9, No. 2, 93-108 (1959). In German.
Subjective loudness measurements are described and the
ssibility of objective estimates discussed. The loudness proves
depend, within the precision of measurements, only on sound
essure level and frequency bandwidth. There are considerable
ferences between the results obtained from well-known methods
calculating loudness (including the DIN method) and those derived
om subjective measurements.

216 FREQUENCY EVALUATION OF NOISE SPECTRA. E.Lübcke.

ıstica (Internat.), Vol. 9, 243-6 (1959). [Akust. Beihefte, No. 1,
59)]. In German.
In experiments on noise, the sound spectrum is often a factor in
imating the loudness. The curves used for frequency evaluation
discussed and a method suggested of grouping noises into a
inite scale. In practice, according to recent research on the
jective evaluation of objectively equally intense sounds, one
uld favour such a scale of noise for practical purposes.

217 THE ACOUSTIC CONDITIONS ACCEPTED BY LISTENERS IN AN AUDITORIUM.

.B.Nickson and R.W.Muncey.
ıstica (Internat.), Vol. 9, No. 4, 316-20 (1959).
Many acoustical measurements proposed for the assessment of
tening conditions in halls give extremely detailed information
ich has no correlation with subjective judgements. Review of
oustic impressions and criteria over a wide range of halls and
ntries suggests, in fact, that a continuing search for more pre-
e acoustic parameters for binaural listening is not warranted
ause of the wide range of listener tolerances. Acoustical fac-
s that have an effect on subjective appreciation are discussed.

218 MODELS AS AN AID IN THE ACOUSTICAL DESIGN OF AUDITORIA. A.K.Connor.

ustica (Internat.), Vol. 9, No. 5, 403-7 (1959).
Recent published work on acoustic models is briefly reviewed.
ne experiments with a sonic model of an auditorium are des-
bed. The conclusion is reached that, in the present state of
owledge of the relationship between physical measurements and
ojective evaluation of hall performance, sonic models are of
le value as an aid to acoustical design.

219 THE SUBJECTIVE AND OBJECTIVE EVALUATIONS OF THE SOUND PROOFING OF DIVIDING WALLS AND ILINGS. H.J.Rademacher and G.Venzke.

ıstica (Internat.), Vol. 9, No. 6, 409-18 (1959). In German.
Some frequency response curves of sound transmission loss
l impact sound were imitated by means of electric filters. Using
se filters and loudspeakers, tape-recorded noises of different
quency bandwidth were transmitted for subjective judgement.
e loudness of the resulting noises was determined subjectively by
umber of observers comparing them with a third-octave band of
ndom noise with 1000 c/s centre frequency. The comparison of
obtained loudness levels with objective characteristics such as
hallschutzmass" and mean sound transmission loss shows that
se characteristics agree with the subjective judgements within
limits of measuring accuracy, unless extreme frequency re-
nses of the sound transmission loss and extremely wide noise
ds are used.

220 LIGHT WEIGHT WALLS WITH HIGH TRANSMISSION LOSS. G.Kurtze.

ıstica (Internat.), Vol. 9, No. 6, 441-5 (1959).
The unavoidable coupling between adjacent mass elements of a wall has, until now, been understood to be unfavourable with respect to sound transmission loss. The present paper, however, introduces the concept of using this coupling in order to increase the transmission loss above the previously accepted limiting value given by the mass reactance of a perfectly limp wall. A brief theoretical consideration shows that a transmission loss exceeding mass law can, in fact, be achieved with suitable structures. Experimental measurements made on randomly mass-loaded metal foils verify the theoretical result that a significant increase in the transmission loss may be obtained below a certain predetermined limiting frequency. Above this frequency the resulting transmission loss is approximately constant.

221 DESIGN OF ACOUSTIC RESONATOR PANELS. C.R.Nagaraja Rao.

J. sci. industr. Res. (India), Vol. 19A, No. 10, 506-9 (Oct., 1960).
A variant of the Helmholtz formula was employed for the direct calculation of the peak absorption frequencies of cavity resonator panels with a number of apertures of different diameters. Lining the cavity with a relatively thin layer of absorbent material was found to increase the absorption without changing the frequency at which the absorption curve shows a peak. Designs of panels, effective in different frequency ranges, were worked out using the modified formula and tested experimentally. Design considerations to take into account when panel thicknesses or cavity depths are altered are indicated. The investigation has revealed that it is possible to formulate rigorous design criteria for resonator panels effective in any desired frequency region.

222 [ARCHITECTURAL] ACOUSTICAL INVESTIGATIONS IN THE LIEDERHALLE, STUTTGART, USING NEW MEASURING TECHNIQUES. W.Junius.

Acustica (Internat.), Vol. 9, No. 4, 289-303 (1959). In German.
Techniques for studying the acoustical conditions in a large concert hall are considered. A microphone having a spherical-wave characteristic is used, in conjunction with a c.r.o., to record the reverberation of a very short acoustic pulse, and to study the reverberation energy distribution with time. A strongly directional microphone allows the directional diffusitivity to be recorded and analysed. The results are discussed from the aspect of geometrical room acoustics.

223 THE ACOUSTICS OF THOMASKIRCHE, LEIPZIG. L.Keibs and W.Kuhl.

Acustica,(Internat.), Vol. 9, No. 5, 365-70 (1959). In German.
Because of uncertainty in the reported values of reverberation time in this church, new measurements were made both in the empty church (4 s) and with a choir or orchestra and varied numbers of congregation present. Because of rebuilding in the last hundred years, the reverberation time has changed from that in Bach's time (1.6 to 1.7 s with audience) to the present (1.9 s with audience). Comments are made on the relations between this rather small reverberation time and Bach's compositions and on the number of musicians of choir and orchestra at that time.

OPTICS . PHOTOMETRY

224 OPTICS OF ALL WAVELENGTHS [Optik aller Wellenlangen]. Edited by P.Görlich and R.Tiedeken.

Berlin: Akademie-Verlag (1959) 395 pp.
Proceedings of the meeting of the Physikalische Gesellschaft of the German Democratic Republic, held in Jena on 2-5 November 1958. Fifty-two papers were presented in the following subject groups: Fundamental, Semiconductors, Spectroscopy, Spectral apparatus, Physiological optics, Scattering theory, Geometrical optics, Microscopy, Testing objectives, Special problems of technical optics and related topics. Abstracts of most of these contributions will be published in this or succeeding issues of Physics Abstracts.

225 ALLVAR GULLSTRAND. M.Herzberger.

Optica Acta (Internat.), Vol. 7, No. 3, 237-41 (July, 1960).
An appreciation of Gullstrand and his contribution to optics.
R.A.Weale

226 COHERENCE PROPERTIES OF BLACKBODY RADIATION. R.C.Bourret.

Nuovo Cimento (Italy), Vol. 18, No. 2, 347-56 (Oct. 16, 1960).

An explicit calculation of the space and time correlation functions of the electric field components in blackbody radiation is given. These functions are determined by the statistics of a photon gas since the Planck distribution law is essentially the power spectrum of the field fluctuations. The spatial coherence functions are developed in close analogy with the theory of isotropic turbulence of an incompressible fluid.

227 WIDE-ANGLE PHOTOELECTRIC INTEGRATING FLASHMETER. J.Edwards, W.R.Lane and B.R.D.Stone.
J. sci. Instrum. (GB), Vol. 37, No. 12, 452-4 (Dec., 1960).

The design, construction and calibration of a compact portable battery-operated photoelectric integrating photometer, which was developed for measuring very low levels of luminous energy incident on a surface from a distant light flash at night, is described. The instrument has a linear response and on its most sensitive range gives full-scale deflection for an exposure of 0.004 lx s. Drift, arising from the photocell dark current and night-sky background illumination is neutralized by feeding into the integrating capacitor a variable compensating current. Six ranges of sensitivy are provided, and colour filters can be inserted for measurements in restricted wavebands.

GEOMETRICAL AND INSTRUMENTAL OPTICS SPECTROSCOPY

(Optical spectra and their analysis are included under the appropriate heading, e.g. Atoms, Molecules, Solid-State Physics, etc.)

228 THE COMPUTATION OF WAVEFRONTS.
F.I.Havlíček.
Optica Acta (Internat.), Vol. 6, No. 4, 406 (Oct., 1959). In German.

It is claimed that, in the method of Picht (Abstr. 3599 of 1956; 7920 of 1959) for calculating the coordinates of a wavefront as power series from the power series for the ray aberration, if all coefficients except one high order one of the ray aberration power series are zero then the method leads to very high values for all coefficients of lower orders in the wavefront power series. This is avoided in an alternative method proposed by the author (Abstr. 7919 of 1959). W.T.Welford

229 ACTIVE CONTRAST-TRANSFER THEORY.
A.Lohmann.
Optica Acta (Internat.), Vol. 16, No. 4, 319-38 (Oct., 1959). In German.

"Active" signifies the design of instruments or techniques with a given contrast-transfer function (CTF) as opposed to the determination or computation of the CTF of a given system. This is a review of existing applications, including phase and amplitude pupil filters, photographic sharpening techniques and electronic devices for changing contrast. 52 references. W.T.Welford

230 RENDERING PHASE OBJECTS VISIBLE IN A MICROSCOPE BY MEANS OF INTERFERENCE FILTERS.
R.Speidel.
Z. Phys. (Germany), Vol. 160, No. 4, 375-84 (1960). In German.

Three methods are considered to make phase-objects visible in a normal microscope in transmission with higher resolution and improved contrast. Calculations and experiments show that when a thin phase-object is vacuum evaporated and embedded in an interference filter, it provides an increased contrast that is about 10 times better than the method of phase-contrast used by Zernike. Living phase-objects are in a liquid between the two semisilvered glass plates. They are made visible by the shift in the colour against the surroundings. Whereas the phase-contrast method could detect a phase-object of 100 A thick, an object an thin as 10 A could be seen by the interference filter method. To increase the contrast of the surface structure of a thick object (e.g. crystal blocks which are transparent) the interference filter is formed on the surface of the object. It provides a similar effect of dintinguishing the edges but with greater plasticity as compared with the phase-contrast method. A series of pictures demonstrate the advantages of this method. The filter formed on the surface of the crystal succeeds in detecting the submicroscopic irregularities of surface structure as seen by the condensed water droplets which are made visible.

231 COMMENT ON MULTILAYER DIELECTRIC FILTERS.
H.L.Armstrong.
Austral. J. Phys., Vol. 13, No. 2, 192-3 (June, 1960).

Attention is drawn to the fact that many subjects such as the theory of the multilayer filter, the Kronig—Penney lattice, problem of cascading networks, etc. can all be handled neatly and effectively by multiple matrices. In a multilayer there is one matrix for each layer and the superposition of layers is represented by multiplying the matrices. It is advantageous to use cascaded or iterated structures, by using general matrix methods rather than treating each as a special case. See also Abstr. 6912 of 1960. S.Tolansk

232 A MICRODENSITOMETER OF HIGH RESOLVING POWER AND ITS APPLICATION TO THE MEASUREMENT OF THE CONTRAST OF PERIODIC PATTERNS.
H.Thiry.
Bull. Soc. Roy. Sci. Liege (Belgium), Vol. 29, No. 9-10, 258-71 (Sept.-Oct., 1960). In French.

A recording microdensitometer has been built for studying the contrast transmission of interferometer patterns. The scanning aperture is a slit of width 1 μ and length 380 μ. The response function was calculated and verified for square-wave signals.

SPECTROPHOTOMETER AND POLARIMETER FOR U.V. STUDY OF THE SKY. See Abstr. 21387 of 1960.

233 TEMPERATURE-CONTROL SYSTEM FOR USE WITH SPECTROPHOTOMETER. S.W.Thorne.
J. sci. Instrum. (GB), Vol. 37, No. 12, 478-80 (Dec., 1960).

A scheme is outlined for the accurate control of the temperatu of a standard 5 cm cuvette and contents. Any temperature over, fo example, a range of 30-80° C may be selected to an accuracy of ±0.1° C with a subsequent control variation of the order of ±0.05° C. A check-point and interpolation method is described to achieve this selection accuracy. An electromagnetic method designed to provid remote stirring is indicated.

234 A PRIMARY SPECTROPHOTOMETRIC STANDARD O HIGH ACCURACY. J.P.Mehltretter.
Z. Astrophys. (Germany), Vol. 51, No. 1, 32-48 (1960). In German.

A system of standard light sources and techniques are describ for measuring the absolute spectral brightness distribution of spectrophotometric comparison lamps in the wavelength range 3000-12000 A. The system includes as a primary standard a black body at 2500° K, whose deviations from Planck's law are smaller than 0.3%. The temperature of the black body is measured by a direct photoelectric method with an accuracy of ±2° at 2500° K, including nearly all systematic errors. Several tungsten ribbon lamps, which have been compared to the black body, are used as secondary working standards.

235 SCEPTRE III — AN INTENSE SOURCE OF THE SPECTRA OF HIGHLY IONIZED ATOMS.
A.S.Kaufman, T.P.Hughes and R.V.Williams.
Proc. Phys. Soc. (GB), Vol. 76, Pt 1, 17-24 (July, 1960).

Draws attention to the potentialities of the high-current toroid discharge assembly, SCEPTRE, as an intense source of the higher spectra. By way of illustration, several new classified lines of Ne IV, V and VI which were observed in the range 2200 A to 2300 A are reported, thus permitting some revision of, and extension to, the analyses of these spectra. The complete F VI triplet $3s\,^3S-3p\,^3$ was also observed for the first time. Two new experimental metho of differentiating between the stages of ionization are given. With SCEPTRE, in contrast to conventional sources of spark spectra, gaseous samples are easily introduced into the deuterium plasma. Thus, such a discharge apparatus will be of value in exciting the spectra of the rare gases. Experimental evidence is presented to show that the contribution of the Stark effect to the large observed widths of O V and F VI lines is very small. Consideration is also given to the detection of the coronal lines with SCEPTRE and to their value in studying ion motion within the plasma.

PHYSICAL OPTICS

(Luminescence is included under Solid-State Physics, Liquid State, or Gaseous State)

236 OPTICAL PROPERTIES OF THIN Al FILMS BETWEEN 2537 AND 5460 A.

Lennuier, D.Lagarde and F.Filippi.
v. Opt. (France), Vol. 38, No. 11, 493-504 (Nov., 1959). In French.

The technique is described for preparing thin films which
ibit the lowest possible absorption coefficient for a given thick-
ss. The measurement of their reflection and transmission
efficients is considered. Experimental results are given concern-
(1) the change in reflection, transmission and absorption in terms
the wavelength for various thicknesses; (2) the change in absorp-
n with thickness for various wavelengths; (3) the time variation
the films.

237 THE JOHNS HOPKINS UNIVERSITY AND DIFFRACTION GRATINGS. J.Strong.

Opt. Soc. Amer., Vol. 50, No. 12, 1148-52 (Dec., 1960).

Contributions to the history of the diffraction grating art are
forth in the form of quotations from John Hopkins records and
er sources.

238 HUYGHENS' PRINCIPLE AND THE DIFFRACTION OF LIGHT. I. THEORETICAL CONSIDERATIONS.

7.Raman.
oc. Indian Acad. Sci. A, Vol. 50, No. 2, 83-90 (Aug., 1959).

The conventional treatment of diffraction problems based on
so-called Principle of Huyghens as analytically formulated by
rchhoff is based on a misunderstanding of the original ideas of
yghens regarding the propagation of light. It seeks to express
luminous effect due to the primary source as a summation of
effects of secondary sources situated on the elementary areas
a surface in free space enclosing the point of observation. Since
diffraction of light is a consequence of the presence of obstacles
the path of the light waves, the optical character of the obstacles
l their configuration in space are of the very essence of the
blem. It follows that the approach adopted in the Kirchhoff
ory is misconceived and erroneous. It is however possible to
e a theory of diffraction on Huyghens' concept of partial waves
l his explanation of the reflection and refraction of light at the
ndary between media with different optical properties. But this
ds to results which differ fundamentally from those indicated by
rchhoff's formula. It is shown that the issue which thus presents
elf is readily capable of experimental test.

239 CAUSTICS FORMED BY DIFFRACTION AND THE GEOMETRIC THEORY OF DIFFRACTION PATTERNS.

7.Raman.
oc. Indian Acad. Sci. A, Vol. 49, No. 6, 307-17 (June, 1959).

The Fresnel patterns of elliptic disks and apertures afford a
iking example of the power of the geometric method in treating
theory of diffraction patterns. They are discussed in detail
l series of photographs exhibiting the features indicated by the
ory are reproduced.

240 HIGH-FREQUENCY DIFFRACTION OF PLANE WAVES BY AN INFINITE SLIT. I. S.R.Seshadri.

ic. Nat. Inst. Sci. India A, Vol. 25, No. 6, 301-21 (Nov., 1959).

The scattering of plane electromagnetic waves of wave number
an infinite slit of width 2a formed by two perfectly conducting
ni-infinite coplanar screens of zero thickness is considered.
the case when the direction of the incident electromagnetic wave
n a plane perpendicular to that of the screens and when the slit is
ented such that its edges are parallel to the incident magnetic
tor the asymptotic series for the transmission cross-section per
length of the slit is determined up to the order $(ka)^{-4}$. The
eralization of the method for the treatment of the case when the
ection of the incident electromagnetic wave is not restricted to
n a plane perpendicular to that of the screens is also worked
Graphical plots of the transmission coefficients of the infinite
per unit length are included.

241 HIGH-FREQUENCY DIFFRACTION OF PLANE WAVES BY AN INFINITE SLIT. II. S.R.Seshadri.

oc. Nat. Inst. Sci. India A, Vol. 25, No. 6, 322-36 (Nov., 1959).

The case where the slit is oriented such that its edges are
allel to the incident electric vector is examined and the asymptotic series for the transmission cross-section per unit length of the slit is determined up to the order $(ka)^{-5/2}$. The method for generalizing the results for the case when the direction of the incident wave is not restricted to lie in a plane perpendicular to that of the screens is indicated. Graphical plots of the transmission coefficients of the slit per unit length are also given.

242 THE DIFFRACTION OF LIGHT BY TWO SUPERPOSED PARALLEL SUPERSONIC WAVES BEING HARMONICS OF THE SAME FUNDAMENTAL. R.Mertens.

Proc. Indian Acad. Sci. A, Vol. 50, No. 5, 289-300 (Nov., 1959).

The diffracted light field is written as a Fourier series in space and time, the coefficients of the space variables being solutions of a system of difference-differential equations; the time-dependent parts of the Fourier series give the frequency changes in the diffracted light and the directions in which different orders are diffracted are given by the usual formulae. The system of difference-differential equations is solved with the assumption that the wavelengths of the ultrasonics and the amplitudes of the refractive index changes they produce are large; some symmetry properties of the diffracted field are obtained. W.T.Welford

243 MOLECULAR THEORY OF LIGHT SCATTERING BY MULTI-COMPONENT SYSTEMS [OF OPTICALLY ANISOTROPIC MOLECULES]. S.Kielich.

Acta phys. Polon. (Poland), Vol. 19, No. 5, 573-97 (1960).

General expressions, accounting for the degree of depolarization D of the light scattered, for Rayleigh's ratio S, and for the turbidity h of the medium are derived. These expressions contain the molecular factors F_{is} and F_{anis} of isotropic and anisotropic light scattering, respectively; these are discussed with special reference to multi-component systems of: (1) anisotropic molecules with constant polarizability; (2) dipolar molecules with hyperpolarizability; (3) non-dipolar molecules with quadrupole moments. Formulae are derived relating anisotropic light scattering and the optico-optical birefringence of the medium, and others relating isotropic light scattering to the divergence between the molecular refraction of the substance in the condensed and gaseous states. Applications to one-component systems are given.

244 EXPERIMENTAL STUDY OF THE MULTIPLE SCATTERING OF LIGHT. S.Isacchi and J.Lenoble.

Rev. Opt. (France), Vol. 38, No. 5, 217-40 (May, 1959). In French.

Luminance measurements were made of light scattered in polyvinyl chloride and acetate suspensions. Luminance curves are given for various optical densities of the scattering layers and for various illuminating directions. The results may be used to verify current theories of multiple light scattering.

ON THE PHOTOELASTIC EXAMINATION OF VIBRATING BODIES AND THE PHOTOELASTIC EFFECT IN OPTICALLY ACTIVE MEDIA. See Abstr. 97

PHOTOGRAPHIC LIGHT SCATTERING BY POLYETHYLENE FILMS. See Abstr. 21221 of 1960.

COLORIMETRY . PHOTOGRAPHY

245 DETERMINATION OF THE TINT AND GREYNESS OF DIFFUSING PLASTICS (POLYETHYLENE) USING A REFLECTION PHOTOMETER. R.Huber.

Z. angew. Phys. (Germany), Vol. 12, No. 10, 469-76 (Oct., 1960). In German.

By measuring the reflection factor of a sheet of diffusing material when backed by (a) a standard white surface and (b) a black surface, it is possible to calculate the extinction and scattering indexes of the Kubelka—Munk analysis. These can be used to provide a measure of the degree of coloration and the greyness of the material. The author has applied the method to a number of materials of the polyethylene type, with and without the addition of Ti oxide.
J.W.T.Walsh

246 THE GRANULARITY OF PHOTOGRAPHIC FILMS UNIFORMLY EXPOSED. THEORETICAL AND EXPERIMENTAL STUDY. M.Savelli.

Rev. Opt. (France), Vol. 38, No. 6, 269-81 (June, 1959). In French.

The statistical properties of the transparency of photographic films are examined in connection with their granularity. A mathematical model depending upon only a small number of parameters is presented and shown to account suitably for the observed statistical properties.

HEAT . RADIATION

247 HEAT TRANSFER TO BINGHAM PLASTICS IN LAMINAR FLOW THROUGH CIRCULAR TUBES WITH INTERNAL HEAT GENERATION. R.S.Schechter and E.H.Wissler.

Nuclear Sci. Engng (USA), Vol. 6, No. 5, 371-5 (Nov., 1959).

An analytic solution has been obtained for a problem arising in the flow of a Bingham plastic through a circular tube with constant internal heat generation. The associated eigenfunctions have been evaluated numerically, and the resulting eigenvalues are tabulated. Using these eigenfunctions a solution can be obtained for arbitrary heat generation and wall flux.

PLANE DYNAMIC PROBLEM OF THERMOELASTICITY CONCERNING A CIRCULAR HOLE. See Abstr. 84

248 THERMAL CONDUCTIVITY AND EUCKEN TYPE CORRECTION FOR BINARY MIXTURES OF N_2 WITH SOME RARE GASES. A.K.Barua.

Physica (Netherlands), Vol. 25, No. 12, 1275-86 (Dec., 1959).

The thick-wire variant of the hot-wire method has been used to measure the thermal conductivity of the binary mixtures N_2—He, N_2—Ne, N_2—Kr and N_2—Xe at 30° C and 45° C. The experimental data for pure N_2 and the binary mixtures have been compared with the recent theory of Hirschfelder. Reasons have been put forward for the discrepancy observed between the experimental and the calculated values of the thermal conductivity of pure N_2 given by the Hirschfelder's theory. The formula for the thermal conductivity of gas mixtures is found to represent the concentration dependence of the conductivity satisfactorily. The simpler formula for the thermal conductivity of gas mixtures given by Mason and Saxena (Abstr. 1368 of 1959) has also been tested.

THERMAL CONDUCTIVITY OF BINARY GAS MIXTURES. See Abstr. 159

249 HEAT TRANSFER IN AN ANNULUS WITH AN INNER ROTATING CYLINDER.

F.Tachibana, S.Fukui and H.Mitsumura.

Bull. JSME (Japan), Vol. 3, No. 9, 119-23 (Feb., 1960).

Heat transfer by convection in the annular gap between a rotating inner cylinder and a stationary outer cylinder was measured in air, spindle oil and mobile oil at varying rotational speeds, cylinder diameters and widths of gap. The results show that characteristics of the flow and heat transfer have two modes. If the rotational speed is low and the width of gap is narrow, namely $(v\delta/\nu)\sqrt{\delta/r} < 41$, the flow is laminar and the heat is transferred by conduction and radiation. But if $(v\delta/\nu)\sqrt{\delta/r} > 41$, the rate of heat transfer increases with rotational speeds under the influence of secondary vortices induced by the centrifugal force, which may be given by

$$\frac{U\delta}{\lambda} = 0.21\left(\frac{v^2\delta^2}{\nu^2} . \frac{\delta}{r} .\right)Pr^{1/4}$$

where U denotes the overall coefficient of heat transfer through the gap, δ the width of the gap, λ the thermal conductivity, ν the kinematic viscosity and Pr the Prandtl Number, r and v the radius and the peripheral velocity of the rotating cylinder respectively.

250 FREE-CONVECTION HEAT TRANSFER IN THE INCLINED OPEN THERMOSYPHON. B.W.Martin.

Proc. Instn Mech. Engrs (GB), Vol. 173, No. 32, 761-78 (1959).

Describes a fundamental experimental investigation of heat transfer by free convection in a static heated tube, sealed at its lower end, and arranged so that the inclination of the tube to the vertical can be varied. Heated fluid adjacent to the tube wall forms an annulus which is discharged from the open end into a suitably cooled large reservoir, while a central core of cool fluid is continuously drawn into the tube by way of replacement. The case of the vertical tube under both laminar and turbulent flow conditions has been previously studied [Proc. Roy. Soc. A (GB), Vol. 230, 502 (July 7, 1955)] and the present work continues the investigation of the system. Inclination of the tube sets up a secondary acceleration normal to its principal axis. The pressure gradients which are thereby induced should assist the circulation of fluid from the cold to the hot stream, thus reducing the thickness of the annulus and increasing the area of the core. The increased effectiveness of the system might then be expected to improve the heat-transfer rate. This is found to be true in laminar flow (of the boundary layer type) except for small tilting angles. The weak secondary pressure gradients which then occur are believed to be responsible for mingling of the fluid particles on the common boundary, and this reduces the heat transfer. The same general trends are apparent even when there is some degree of turb lence in the system. The stable turbulent regime is not of the boundary-layer type, because of the tendency for the cool entering fluid also to become turbulent, but what is called fully mixed flow, where the tow turbulent streams mix. This causes reduced circulation and heat transfer. Under these conditions sufficient tilting of the tube eventually brings about the elimination of the mixing effect and a more efficient transfer of fluid particles between the two streams. The greatly increased heat transfer appears to be consistent with a stable turbulent boundary-layer flow regime, which, if attained, would improve the effectiveness of the open thermo-syphon as a cooling device for both nuclear reactors and gas-turbine rotor blades.

251 HEAT TRANSFER BETWEEN A LIQUID-FLUIDIZED BED AND THE CONTAINER WALL.

E.Ruckenstein, V.Shorr and G.Suciu.

Stud. Cercetari Fiz. (Roumania), Vol. 10, No. 2, 235-46 (1959). In Roumanian.

An experimental study of the heat transfer between a bed fluidized by gas-oil or water and the container wall. The interpretation of these experimental results is made by means of a model similar to that suggested by Levenspiel and Walton. (1954). The experimental results are also correlated by means of empirical equations.

252 MEASUREMENT OF THERMAL FLUCTUATIONS IN RADIATION. M.Harwit.

Phys. Rev. (USA), Vol. 120, No. 5, 1551-6 (Dec. 1, 1960).

The thermal fluctuations in radiation are described by the Einstein—Fowler relation $\langle(\Delta E)^2\rangle = kT^2(\partial\langle E\rangle/\partial T)$. Two terms contribute to this fluctuation, a photon shot noise term and an expression predicted by wave theory. In the present experiment the second term was measured.

253 INFORMATION CAPACITY OF RADIATION DETECTO R.C.Jones.

J. Opt. Soc. Amer., Vol. 50, No. 12, 1166-70 (Dec., 1960).

The information capacity of a radiation detector is denoted by C and is measured in bits per second. The root-mean-square radiation power incident on the detector is denoted by P and is measured in watts. The ratio C/P = I is measured in bits per joule When I is referred to unit detector area, it is denoted by I^* and is measured in bits per (joule/cm). It is shown that for most detectors the information capacity I has a maximum value for a finite and determinable value of the power P, and that the maximum corresponds to an electrical signal-to-noise ratio in the output of the detector that is of the order of magnitude of unity. It is further shown, subject to a suitable simplifying approximation, that the information capacity I^* is equal to one-half of the energy detectivity Δ_m^* of the detector, and that if the modulation of the radiation power is confined to one cps band centred at the frequency f, the informati capacity I^* is equal to the detectivity D* (f) of the detector. The analysis of the information capacity is divided into two parts. Using a simplifying approximation numerical results for a number of kind of detectors, including the dark-adapted human eye, Royal-X photographic film, multiplier phototubes, and cooled infrared detectors are obtained. An exact analysis for two important cases is given.

Liquid and Solid Helium

254 THE FORM OF THE [ENERGY] SPECTRUM OF ELEMENTARY EXCITATIONS IN LIQUID HELIUM II.

L.P.Pitaevskii.

Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 1(7), 216-17 (July, 1960 In Russian.

A theoretical graph is shown which expresses the energy levels of liquid helium as a function of the linear momentum of the elementary excitations. In this graph the energy rises from 0 to a maximum; at higher values of the momentum, the energy passes through a minimum where its value is denoted by Δ . With increasing momentum, the energy rises again and approaches the val 2Δ = 17.2° K (in units of temperature). To any further increase of momentum, the energy responds with an abrupt drop towards 0.

e author discusses results of neutron scattering experiments. It d been found that the second derivative of the momentum--energy rve is negative near energies ≅ 2Δ. This result had been inter- eted as being an indication for a second maximum; the author nts out that it is fully compatible with his own theoretical curve. s further noticed that the experimental probability for generating elementary excitation by neutron impact diminishes markedly if energy comes near 2Δ; this is in qualitative agreement with the hor's theory. [English translation in: Soviet Physics—JETP SA)]. R.Eisenschitz

255 SPECIFIC HEAT OF MIXTURES OF ^{4}He AND ^{3}He BETWEEN 1^{0}K AND 4^{0}K.
Dokoupil, D.G.Kapadnis, K.Sreeramamurty and K.W.Taconis.
ysica (Netherlands), Vol. 25, No. 12, 1369-75 (Dec., 1959).

Heat capacities of mixtures at concentrations of 1.00, 2.50, 3, 21.1 and 41.7% of He^3 in He^4 were measured at liquid helium nperatures above 1^{0}K. The measurements on the 21.1 and 41.7% xtures were performed up to the critical region of the respective xture. Special attention was paid to the accurate determination of transition temperature; the value of the λ-points gave a negative ft of 1.48 degree per mole concentration in agreement with the sults of other authors.

256 SOUND VELOCITY, PHASE SEPARATION, AND LAMBDA TRANSITIONS OF He^3—He^4 MIXTURES.
R.Roberts and S.G.Sydoriak.
ys. of Fluids (USA), Vol. 3, No. 6, 895-902 (Nov.-Dec., 1960).

The velocity of first sound has been measured in saturated uid He^3—He^4 mixtures ranging in composition from 20 to 90% He^3 ween 0.5° and 2.3°K. The velocities decrease with increasing concentration due to the large increase in compressibility. The nperature T_S at which a liquid mixture first begins to separate two layers of different composition is identified by a break in temperature derivative of the sound velocity. The values of T_S compared with and found to agree well with all other recent ect measurements. Breaks also occur in the temperature ivatives of first sound velocity and signal amplitude at tempera- es which in good agreement with most recent determinations of nbda transition temperatures for concentrations up to 30%. For her concentrations, the values obtained are in good agreement h λ points determined from second sound measurements but er markedly from results based on the disappearance of boiling. ssible reasons for the differences are discussed. A smoothed le of λ temperature as a function of concentration is given up to intersection of the λ line and the phase separation region at He^3 and 0.86°K. The vapour pressure of pure He^4 at its lambda nt is 37.80 ± 0.01 mm Hg (at 0^{0}C and standard gravity) based on measured vapour pressure at the minimum sound signal and a culated displacement of the sound minimum from the lambda nt.

257 THEORY OF THE COMPRESSIBILITY OF SOLID He^4 AND He^3 AT 0^{0}K. N.Bernardes.
ys. Rev. (USA), Vol. 120, No. 6, 1927-32 (Dec. 15, 1960).

A quantum mechanical variational method is used to calculate veral properties of a close-packed lattice phase of solid He^4 and ^{3} at 0^{0}K. The method consists in expressing the expectation value the interatomic potential energy, with respect to a Heitler--London al wave-function, as a series of powers of the mean square devi- on of an atom from its lattice site. Due to the small mass of a lium atom this mean square deviation is relatively large and the ries converges slowly. Three sets of numerical results are ob- ned by truncating the series after the first, second, and third m, respectively. A comparison of these results with the experi- ntal data shows that the final results, i.e. after minimizing $\langle H \rangle$ h respect to the variational parameter, converge much faster than expectation value series itself. The results include values for: esive energy, sound velocity, compressibility, Debye temperature, l Grüneisen constant. The calculations are repeated for a body- ntred cubic lattice, and no indication of a crystallographic phase nsition.

uperconductivity

258 PRESSURE AND VOLUME EFFECTS IN SUPER-CONDUCTIVITY. H.Rohrer.
lv. phys. Acta (Switzerland), Vol. 33, No. 6-7, 705 (1960).
German.

The change of length of Sn, Pb, Tl, Ta, La and V polycrystals l In and Hg single crystals at the superconducting transition was measured with an optical lever system down to 1.4^{0}K. From this, the change of the critical magnetic field under pressure and the volume dependence both of the critical temperature T_c and of the density of levels at the Fermi surface N, were calculated.

	In	Sn	Pb	Hg	Tl	Al	Cd	Ta	V	La
$\frac{\nu}{T_c}\frac{\partial T_c}{\partial \nu}$	5.2	6.6	3.1	3.0	−1.5	17	24.5	3	−3.5	−0.5
$\frac{\nu}{N}\frac{\partial N}{\partial \nu}$	1.0	2.7	3	10	3.4	8	−9	6	−0.6	−3.4

Where ν is the volume. The volume dependence of the density of levels is found to be normal for In, Sn, Pb, Ta, V, and La, but extremely large for Hg, Cd and Al. A qualitative explanation is given for the extraordinary behaviour of the latter three superconductors. It was found that the volume dependence of the total electron—electron interaction of the B.C.S. theory is the same for nearly all superconductors.

259 ISOTOPE EFFECT IN Nb$_3$Sn.
G.E.Devlin and E.Corenzwit.
Phys. Rev. (USA), Vol. 120, No. 6, 1964-5 (Dec. 15, 1960).

The isotope effect on the superconducting transition of Nb$_3$Sn was measured using Sn^{116} and Sn^{124}. The value of −0.08 for the exponential factor is only $\frac{1}{5}$ of that of the elemental superconductors which have been reported.

260 R.F. HALL EFFECT IN A SUPERCONDUCTOR.
G.Dresselhaus and M.S.Dresselhaus.
Phys. Rev. (USA), Vol. 120, No. 6, 1971-4 (Dec. 15, 1960).

The r.f. Hall field in a superconductor is calculated for the applied d.c. magnetic field and the r.f. electric field both parallel to the metal surface. A two-fluid model and specular reflection boundary conditions are used to solve the transport problem in the limits of the classical and the extreme anomalous skin effects. It is found in both limits that the r.f. Hall effect is nonzero. The magnitude of the Hall angle in superconducting tin is estimated.

THERMAL CONDUCTIVITY OF SUPERCONDUCTING INDIUM.
See Abstr. 20755 of 1960.

ELECTRICITY
ELECTRICAL MEASUREMENTS AND CIRCUITS

261 DEFINITIONS OF RESONANCE AND EXACT CONDITIONS FOR RESONANCE IN SOME ELECTRICAL CIRCUITS. I. DEFINITIONS OF RESONANCE FOR SERIES AND PARALLEL LCR CIRCUITS. E.J.Burge.
Amer. J. Phys., Vol. 29, No. 1, 19-23 (Jan., 1961).

Six definitions of resonance are distinguished and considered for the series LCR circuit. The corresponding exact conditions are derived for each of the four variables and their practical significance discussed. Some of the results for the parallel LCR circuit are briefly considered.

262 STABILITY OF SOME REACTANCE STANDARDS.
L.H.Ford.
J. sci. Instrum. (GB), Vol. 37, No. 12, 463-5 (Dec., 1960).

Examples are given of the behaviour over several years of the working standards of inductance and capacitance maintained at the National Physical Laboratory. The information is supplementary to that contained in previous papers (Abstr. 2586 of 1950; 6191 of 1951).

263 INEXPENSIVE HIGH RESOLUTION WHEATSTONE BRIDGE. K.Eklund.
Rev. sci. Instrum., Vol. 31, No. 9, 1004 (Sept., 1960).

A modified circuit of the Wheatstone bridge by which extremely small changes of resistance can be measured. V.Bradić

ELECTROSTATICS . DIELECTRICS

(The study of solids through their dielectric properties is included under Solid-State Physics; similarly for Liquid State and Gaseous State)

264 GENERATION AND APPLICATION OF ELECTROSTATIC POWER.

Nature (GB), Vol. 188, 903-4 (Dec. 10, 1960).

Report of an international colloqium held under the auspices of the CNRS at Grenoble on 24 Sept.-1 Oct., 1960).

265 ALLOWANCE FOR THE PERIODIC PROPERTIES OF SPIRALS WHEN MEASURING DIELECTRIC CONSTANTS OF MATERIALS BY THE SPIRAL WAVEGUIDE METHOD.

V.P.Shestopalov, K.P.Yatsuk and I.D.Bugai.

Zh. tekh. Fiz., Vol. 30, No. 4, 460-3 (April, 1960). In Russian.

For the method, see Radiotekhnika i Elektronika, Vol. 4, No. 3, 547 (1959) and Abstr. 9216 of 1960. The boundary conditions for a dielectric-filled spiral waveguide are taken from Abstr. 9883 of 1959 and 11057 of 1960, and used to write the dispersion equations for different types of spiral, whence explicit expressions are got for ϵ. The method is checked experimentally for vinylite, ebonite and porcelain. D.E.Brown

266 SPACE-CHARGE-LIMITED CURRENTS IN CYLINDRICAL AND SPHERICAL INSULATOR DIODES. B.Meltzer.

J. Electronics and Control (GB), Vol. 8, No. 3, 171-6 (March, 1960).

Calculates, and gives tables for, the space-charge-limited current as a function of potential and dimensions, in the approximation which neglects intrinsic conduction, diffusion and trapping effects. An extension of the Mott—Gurney planar diode theory. B.Meltzer

CURRENT ELECTRICITY ELECTROKINETICS

(The study of solids through their electrical conduction properties is included under Solid-State Physics)

267 PRIMARY CELLS.

D.Naylor.

Contemporary Physics (GB), Vol. 1, No. 4, 287-303 (April, 1960).

The systems of the Leclanché, magnesium and R.M. (mercury) cells are described in detail, together with the less-known air depolarized and reserve type cells. Nuclear cells are still in the development stage and will be used for specialized applications only. Fuel cells are of great interest to the electrical engineer and a great deal of work has been done on this type of cell resulting in the recent production of a practical operating unit.

268 ON THE EFFICIENCY OF CASCADE THERMOGENERATORS. A.I.Burshtein.

Fiz. tverdogo Tela (USSR), Vol. 2, No. 10, 2505-8 (Oct., 1960). In Russian.

The overall efficiency is calculated on the assumption that the quality characteristic of a thermocouple is independent of temperature. The efficiencies for one and for an infinite number of cascades are little different over an overall temperature ratio varying from 1.2 to 3.0. [English translation in: Soviet Physics—Solid State (USA)]. R.Berman

269 ON THE EFFICIENCY OF REFRIGERATING THERMOBATTERY CASCADES. A.I.Burshtein.

Fiz. tverdogo Tela (USSR), Vol. 2, No. 10, 2509-16 (Oct., 1960). In Russian.

The coefficient of performance and heat extracted are calculated as functions of the overall temperature ratio and the number of cascades. The former increases little with the number of cascades beyond two, while for the important temperatures the latter decreases with increasing number of cascades. Although each specific case requires analysis, it is not useful to employ more than three cascades. [English translation in: Soviet Physics—Solid State (USA)]. R.Berman

IONIZATION

270 IONIZATION GROWTH IN A GAS WITH A CONSTANT ELECTRIC FIELD. E.Gerjuoy and G.W.Stuart.

Phys. of Fluids (USA), Vol. 3, No. 6, 1008-15 (Nov.-Dec., 1960).

A model for the growth of ionization in a gas with a uniform electric field is studied by Laplace transform techniques. The total electron--molecule cross-section is taken inversely proportional to the velocity; the ionization cross-section may have arbitrary velocity dependence; all secondary electrons are created with zero energy; all collisions scatter electrons isotropically but produce no energy loss. With this model, in the steady-state spatially dependent case that primary electrons are continuously furnished by a cathode at z = 0, an exact solution is found for Townsend's α and for the asymptotic (valid at large z) electron distribution function integrated over velocity orientation. Similarly, in the spatially homogeneous time-dependent case that primary electrons are furnished at t = 0 by a uniformly distributed source, an exact solution is found for the time rate of ionization growth and for the asymptotic (valid at long times) electron distribution function integrated over velocity orientation. Numerical results, including effective electron temperatures are presented for several assumed ionization cross-sections. Because of the neglect of energy loss, applicability of the model is limited to the high E/p (electric field/pressure) range.

271 NONLINEAR BEHAVIOR OF THE ELECTRICAL CONDUCTIVITY OF A SLIGHTLY IONIZED GAS.

M.Epstein.

Phys. of Fluids (USA), Vol. 3, No. 6, 1016-18 (Nov.-Dec., 1960).

Attention is directed to the nonlinear relationship between the current density and field strength of an applied oscillating electromagnetic field. It is pointed out that the general solution of this problem obtained by Margenau (Abstr. 2121 of 1946) is too complex for use in further analyses except for the limiting case of vanishing field strength. A further approximation is introduced which yields a relatively simple expression for the current-field strength relationship, valid for large frequencies and moderate field strength It is found that significant nonlinear effects may occur even at small field strengths if the gas density is sufficiently low. The effect of the nonlinearity is to increase that part of the current in phase with the applied field.

272 AN INVESTIGATION OF THE ELECTRON COMPONENT OF ELECTRON AVALANCHES IN UNIFORM FIELDS. II.

L.Frommhold.

Z. Phys. (Germany), Vol. 160, No. 5, 554-67 (1960). In German.

For Pt I, see Abstr. 12401 of 1959. Electron avalanches in uniform electric fields were studied by means of a short duration spark light source. Electron drift velocities v_- were measured in hydrogen, nitrogen, oxygen, and some vapours. It is shown that in hydrogen and nitrogen, the number of electrons increases exponentially by gas amplification with a time constant $1/\alpha v_-$, in accordance with a conventional assumption and with previous measurements in methane; α is the first Townsend coefficient. In oxygen and air it is, however, demonstrated that the number of electrons increases considerably less than $\exp(\alpha v_- t)$, and that the multiplication process takes longer. This is evidently due to time losses of the electrons on their paths across the gap. Thus the mean time interval for successors, started by photons at the cathode, is increased. In addition, details are given of some measurements of the first Townsend coefficient α, the electron diffusion coefficient, and ionic drift velocities for certain gases.

273 MASS SPECTRUM AND APPEARANCE POTENTIALS OF TETRAFLUOROHYDRAZINE.

J.T.Herron and V.H.Dibeler.

J. chem. Phys. (USA), Vol. 33, No. 5, 1595-6 (Nov., 1960).

A brief report of some of the authors' experimental observation is given. Amongst the values cited are $I(N_2F_4) = 12.04 \pm 0.10$ eV; $D(F_2N - NF_2) = 53$ kcal; $A(NF_2^+) = 12.7 \pm 0.2$ eV. W.J.Orville-Thoma

274 FREE PATH FORMULAE FOR THE COEFFICIENT OF DIFFUSION D AND VELOCITY OF DRIFT W OF IONS AND ELECTRONS IN GASES. L.G.H.Huxley.

Austral. J. Phys., Vol. 13, No. 3, 578-83 (Sept., 1960).

In derivations of formulae for D and W for electrons by the method of free paths (Abstr. 6236 of 1957; 5073 of 1958) the ssumption was made that along a number of successive free paths, electron travels at essentially the same speed c. As this assumption not true of ions, it would not be legitimate to apply the formulae the motion of ions in gases without further discussion. However, e formulae are in fact valid for ionic motion and in this paper ey are established in a more general form.

275 CHARGE EXCHANGE, IONIZATION AND ELECTRON LOSS CROSS-SECTIONS IN THE ENERGY RANGE TO 24 keV. I. T.J.M.Sluyters, E.de Haas and J Kistemaker.

ysica (Netherlands), Vol. 25, No. 12, 1376-88 (Dec., 1959).

The charge exchange, ionization and electron loss cross-sections the reactions A^+ and A in H_2, He, Ne, A, Kr and Xe have been amined in single collision conditions. The total cross-sections ve been determined by using the condenser method. Comparison cross-sections with experimental results of De Heer (Abstr. 8688 1957), Gilbody and Hasted (Abstr. 8376 of 1958) and theoretical sults of Karmohapatro (Abstr. 5854 of 1959) have been made. fferent collision processes in the excited state are possible. The nization cross-sections by ions are higher than the ionization oss-sections by atoms. In some collision combinations the roughly timated distance of interaction for the ionization process is comred with the distance of interaction for charge exchange determined the criterion of Massey (1952).

276 EXCITATION MECHANISM OF Ar⁺ IONS In He, Ne, Ar, Kr AND Xe. II. T.J.M.Sluyters and J.Kistemaker.

ysica (Netherlands), Vol. 25, No. 12, 1389-1404 (Dec., 1959).

In order to obtain information about the excitation processes ised by a monoenergetic ion beam in gases a grating monochromr, built for the spectral range 1000 A to 6500 A, was mounted pendicular to a collision chamber. The spectrograph was calibed against a standard tungsten lamp. Light emission was examd for 5-24 keV A^+ ions in low-pressure noble gases. Arc and rk spectra were measured from the bombarding particle as well from the target gas. The spectral features have been interpreted terms of different collision mechanisms. Absolute optical emisn functions were examined for the A II spectral lines 4610, 4658, 5 and 4806 A in the collision combinations A^+ in He, Ne, A, Kr the Xe II line 2475 A for A^+ in Xe. In the collision combinations in He and Ne the emission cross-section of the line 4658 $^0{}_{1/2} - {}^2P_{3/2}$) is equal to the excitation cross-section of the energy el ${}^2P^0{}_{1/2}$). Influence of cascade effects on the slopes of the differ- emission functions was apparent. The excitation cross-sections he primary argon ions in He are larger than in Ne. In the energy ge of 5 to 24 keV the measured emission cross-sections are ween 1×10^{-19} and 5×10^{-18} cm^2.

277 ION CHARGE-EXCHANGE REACTIONS IN OXYGEN AFTERGLOWS. P.H.G.Dickinson and J.Sayers.

c. Phys. Soc. (GB), Vol. 76, Pt 1, 137-48 (July, 1960).

A method is described for measuring cross-sections for ion rge-exchange at mean ion energies corresponding to gas temperaes of the order of 300° K. The measurements were made in rglows following pulsed radio-frequency gas discharges, using ass spectrometer to identify the ions present, and to observe r relative rates of change of population. The reaction cross- tion for the process $O^+ + O_2 \rightarrow O_2^+ + O$ was deduced from the asured population decay rate of the O^+ ion, at gas temperatures n 200° K to 300° K. The apparent variation of the cross-section gas temperature was not considered to indicate a systematic perature dependence. The cross-section was found to be $\pm 0.5 \times 10^{-16}$ cm^2, corresponding to a rate coefficient of $\pm 0.4 \times 10^{-11}$ cm^3 sec^{-1}, for the process. The relevance of this ult to upper ionospheric studies is briefly discussed.

278 RESONANCE CHARGE TRANSFER IN THE CASE OF POSITIVE POTASSIUM IONS.

.Chkuaseli, U.D.Nikoleishvili and A.I.Guldamashvili.

tekh. Fiz. (USSR), Vol. 30, No. 7, 817-23 (July, 1960).

ussian.

The resonance charge transfer cross-section was measured in range 5-30 keV, by crossing a K^+ beam with a K beam. The ults obtained are higher by a factor of ~1.5 than the theoretical dictions of Firsov (Abstr. 5261 of 1959). [English translation in: iet Physics—Technical Physics (USA)]. S.Chomet

ELECTRIC DISCHARGES

279 SWEPT LANGMUIR PROBE SYSTEM FOR INTENSE GAS DISCHARGES. H.W.Jones and P.A.H.Saunders.

J. sci. Instrum. (GB), Vol. 37, No. 12, 457-9 (Dec., 1960).

The apparatus described provides a pulse of biasing voltage to a probe system so that electron temperatures up to 2×10^5 °K and ion densities up to 5×14^{14} cm^{-3} can be measured. The system consists of a low impedance voltage sweep generator, a transformer-coupled measuring circuit and a logarithmic amplifier. The apparatus can be used to sample a portion or the whole of the electron energy distribution by using double probes of equal or greatly unequal areas. The probe plots are displayed directly on an oscilloscope.

280 MEASUREMENT OF ION SHEATH THICKNESS USING THE DOUBLE PROBE WITH FIXED POTENTIAL.

M.Sugawara and Y.Hatta.

J. Phys. Soc. Japan, Vol. 14, No. 8, 1091-3 (Aug., 1959).

When a negatively biased double probe is used in plasma investigations, the ion sheaths around each probe sometimes overlap. When this is so, the potential of one probe has a marked effect on the current to the other. Using this criterion it is found experimentally that the radius of the ion sheath is proportional to the 0.56 power of the difference in potential between the probe and plasma. D.Walsh

281 DEPENDENCE OF THE JOSHI EFFECT ON "AGEING" UNDER, OR AND IN THE ABSENCE OF, CONTINUOUS ELECTRICAL EXCITATION. M.Venugopalan.

J. Phys. Soc. Japan, Vol. 14, No. 12, 1833-4 (Dec., 1959).

A short report of observations of the influence on the time dependent variations of the Joshi effect (i.e. the incremental variations in discharge current in ozonizer tubes due to photo-illumination) of tube temperature and the continued presence or absence of an exciting field. The author considers the kinetic interchange of molecules at the tube electrodes and their dependence upon the experimental variables and indicates how the electrical state of sorbed layers on the electrode surfaces can lead to the time dependence of the Joshi effect. G.Carter

282 INVESTIGATION OF THE PERFORMANCE OF CONTROLLED SPARK GAPS IN AIR. P.I.Shkuropat.

Zh. tekh. Fiz. (USSR), Vol. 30, No. 8, 954-63 (Aug., 1960).

In Russian.

A study was made of the dependence of pre-breakdown time of a controlled spark gap in air at atmospheric pressure on different conditions of triggering. For minimum pre-breakdown times and minimum scatter, the triggering pulse must be of optimal magnitude, be of opposite sign to the field in the main gap, and must continue during the development of the discharge [English translation in: Soviet Physics—Technical Physics (USA)]. Z.Krasucki

283 ON THE EFFECTS OF THE DISCHARGE GAS ON THE TEMPORAL DEVELOPMENT OF THE CURRENT (I), THE VOLTAGE (V) AND THE SPECTRAL LINE INTENSITY (S) IN SPARK DISCHARGES. R.Eichinger and H.Krempl.

Z. angew Phys. (Germany), Vol. 12, No. 10, 461-9 (Oct., 1960).

In German.

Measurements were made of the variation of I, V and S with time (0-200 µsec) after the discharge of a condenser across a 3 mm gap in air, N_2, A and He, each at a pressure of 700 Torr. It was found that in argon, because of its lower thermal conductivity compared with the other gases, (i) the maintenance potential for the arc, occurring in each half cycle of the oscillatory discharge was less; (ii) there were more half cycles associated with each discharge; and (iii) the variation of S with time was less. The development of I with time, and the maximum temperature (approx. 27 000° K) was found to be the same for all the gases. The results are discussed in terms of the energy balance in the discharge. J.Dutton

284 INSTABILITY OF A POSITIVE COLUMN IN A MAGNETIC FIELD.

T.K.Allen, G.A.Paulikas and R.V.Pyle.

Phys. Rev. Letters (USA), Vol. 5, No. 9, 409-11 (Nov., 1960).

Experiments on the critical magnetic field, beyond which enhanced losses occur from the positive column of a glow discharge, are described. The variation of the critical field with pressure is given for helium with tube radii of 1.27 and 0.9 cm at 400 mA and 200 mA respectively. Results are also given for neon with these conditions. Comparison with theory shows reasonable agreement with recent suggestions (Kadomtsev and Nedospasov), their theory yields perturbation frequencies and wavelengths in good agreement with the experimental results. H.Edels

285 ANODIC OSCILLATION IN GLOW DISCHARGE. I. SIMPLE CORRESPONDENCES OF THE INTERNAL PHENOMENA TO THE OSCILLATION.

K.Ogawa.

J. Phys. Soc. Japan, Vol. 14, No. 12, 1746-51 (Dec., 1959).

Preliminary experiments on the anodic oscillation in glow discharges having no positive column yielded the following results: (1) whenever the oscillation exists a faint small glow ball appears at a small part of the anode. When only one glow ball appears, one series of waves consists of the only kind of waveform. In case of two balls, however, two distinct waveforms appear, and they are smoothly connected when the ratio of the period of each waveform is integer; (2) it is easy to make the glow ball appear, when the anode has very small surface area compared with that of the cathode; (3) the oscillating zone is located only in the glow ball; (4) the degree of modulation of light intensity variation of the glow ball is 100%. The light intensity pulse builds up at the point where the current is minimum, and it reaches to peak preceding the maximum of the current wave. When two glow balls exist they alternately flush, and one of them corresponds to one of current wave and the other to another one. The results are discussed in comparison with a hypothesis hitherto accepted, and they lead to a conclusion in which the conventional theory seems to be not always applicable to quantitative treatment of the oscillatory phenomena.

286 BREAKDOWN STRENGTH OF THICK INSULATING LAYERS IN NON-UNIFORM FIELDS.

F.Obenaus.

Izv. Akad. Nauk SSSR, Ser. fiz., Vol. 24, No. 1, 84-90; Disc. 91-3 (1960). In Russian.

"1958 Moscow Dielectrics Conference" (see Abstr. 16003 of 1960). The type of dependence of breakdown strength on thickness in different fields indicates the nature of pre-breakdown processes. In gaseous insulators, the differences in this dependence for various fields can be accounted for by space-charge effects. To estimate the quality of an insulator (gaseous, liquid or solid), the dependence of its breakdown strength on thickness in both uniform and non-uniform fields must be known. Z.Krasucki

PLASMA

(See also Magnetohydrodynamics)

287 PLASMA RESEARCH.

D.R.Chick.

Contemporary Physics (GB), Vol. 1, No. 3, 169-90 (Feb., 1960).

The reaction power densities for the important nuclear fusion reactions are compared with the radiation losses due to bremsstrahlung and cyclotron radiation. Some properties of an ionized plasma and the particle motions in such a plasma are discussed and methods of containing a plasma within magnetic confining fields are described. The present ideas on the stability of such confining fields, resulting from several theoretical studies, are outlined, and various means of heating the plasma are discussed. The main features of the experimental devices disclosed at Geneva in 1958 are compared, and the leading experimental results reported at the 1959 I.E.E. Convention on Thermonuclear Processes are reviewed.

288 ALKALI VAPOR PLASMAS.

M.A.Hakeem and H.S.Robertson.

J. appl. Phys. (USA), Vol. 31, No. 11, 2063-4 (Nov., 1960).

The positive column of a glow discharge if free from striations would be suitable for many laboratory purposes. Investigations of alkali vapour columns at 0-300 mA and 0.01 to 2.0 mm Hg pressure show no moving striations except at the very lowest values of the range. Oscillations commencing at the anode are rapidly attenuated by the column. Caesium appears to be the most convenient alkali to use for the production of a laboratory plasma.

289 MICROWAVE INVESTIGATION OF PLASMA IN SHOCK TUBE.

M.Takeyama, S.Hamamura and T.Oda.

J. Phys. Soc. Japan, Vol. 14, No. 11, 1637-8 (Nov., 1959).

A shock tube was connected to one arm of a 3 cm wavelength magic T. Strong interaction with the reflected shock was observed. D.Walsh

290 SPECTROSCOPIC INVESTIGATION OF HYDROGEN PLASMA PRODUCED BY AN IMPULSIVE DISCHARGE.

M.Yamamoto.

J. Phys. Soc. Japan, Vol. 14, No. 12, 1739-46 (Dec., 1959).

The time variation of the radiation intensity was observed during an impulsive discharge through hydrogen gas. Oscillogram traces of the intensity of the Balmer lines and continuum are given, and the temperature dependence of the spectral intensity is discussed. The temperature of the plasma at various phases of the discharge current is deduced from the time variation of the radiation intensity, from spectral energy distribution of the Balmer continuum, and from electrical conductivity. It is shown that the agreement between theory and experiment is fairly good for ionization and kinetic temperatures, but poor for the excitation temperature. The H_β line tends to vanish more rapidly than theoretically predicted.

291 SPECTROSCOPIC STUDY OF HELIUM PLASMAS PRODUCED BY MAGNETICALLY DRIVEN SHOCK WAVES.

E.A.McLean, C.E.Faneuff, A.C.Kolb and H.R.Griem.

Phys. of Fluids (USA), Vol. 3, No, 6, 843-56 (Nov.-Dec., 1960).

Measurements have been made of the temperature, density, and degree of ionization of plasmas produced by Mach 30 magnetically driven shock waves in helium (ambient pressure 1 mm Hg). Simultaneous photoelectric intensity measurements of the absolute spectral intensities of He I 3889 A, He I 5876 A, He II 4686 and He II 3203 A indicate temperatures of 3.7 eV, electron and ion densities $\sim 10^{17}$ cm^{-3}, degree of ionization ~99.9% and a density of ~4 across the shock front. The estimated error is ±2% for the temperature and ±12% for the electron and ion densities. The electron density was derived independently from the width of He II 4686 A and agreed with the photoelectric density measurement to within the experimental error for the line width, thus providing a proof of the ionization and excitation equilibrium assumption used in analysing the absolute intensity data. Continuum intensity measurements also provided a check on the consistency of the results. The temperature calculated from the measured shock velocity using the usual Rankine—Hugoniot equations is lower by a factor of about 2, and the density ratio is higher by a factor of about 3. A plausible explanation of this discrepancy is that ultraviolet radiation emitted by the hot plasma in the arc region is absorbed in front of the shock wave.

537.56

292 ELECTRON DENSITY FLUCTUATIONS IN A PLASMA.

E.E.Salpeter.

Phys. Rev. (USA), Vol. 120, No. 5, 1528-35 (Dec. 1, 1960).

The spatial Fourier transform ρ_{ke} is considered for wave vector k of the charge distribution of the electrons in a plasma with particle density, n, electron and ion temperatures T and T_i, and Deb length D. The treatment assumes the absence of a magnetic field, neglects collisions and assumes $nD^3 \gg 1$. The statistical average of $|\rho_{ke}|^2$ is calculated as a function of $\alpha = 1/kD$ assuming complete thermodynamic equilibrium; that component of $|\rho_{ke}|^2$ which keeps in phase with the ion charge density fluctuations is also calculated. The frequency spectrum of the time-varying function ρ_{ke} is obtaine at thermal equilibrium and simplified, assuming the ion mass to be much larger than the electron mass, for general values of α and T/T_i. For small α the main component of the spectrum has the characteristic Doppler broadening shape corresponding to the electron's thermal velocity. For large α there is a component with narrow width corresponding roughly to the ion velocity Doppler spread and very narrow side bands at plus and minus the frequency of electrostatic plasma oscillations.

293 METHOD OF INVESTIGATING THE SPACE DISTRIBUTION OF ELECTRONS IN A PLASMA.

A.I.Anisimov, N.I.Vinogradov, V.E.Golant and B.P.Konstantinov.

Zh. tekh. Fiz. (USSR), Vol. 30, No. 9, 1009-18 (Sept., 1960). In Russian.

A method of determining the space distribution of electrons in plasma by the reflection of electromagnetic waves of various

equencies is described. Taken together with the determination of e mean concentration by the phase shift of a transmitted wave and e maximum concentration by frequency cut-off, this gives the ssibility of a more detailed knowledge of the overall electron stribution. The method is applied to a disintegrating hydrogen asma.
A.E.I. Research Laboratory

294 ION—ELECTRON RELAXATION OF PLASMAS IN A STRONG MAGNETIC FIELD. I. T.Kihara.

. Phys. Soc. Japan, Vol. 14, No. 12, 1751-4 (Dec., 1959).

Relaxation between ion and electron temperatures, T_1 and T_2, f dilute fully ionized gases in a magnetic field is discussed. The ean gyration radius, r_g, is assumed to be much smaller than the ebye length, l_D. The rate of relaxation, R, defined by

$$d(T_2-T_1)/dt=-(T_2-T_1)R,$$

s calculated to be

$$R=(n_1+n_2)(4m_2/3\,m_1)(2\pi kT_2/m_2)^{1/2}(Ze/kT_2)^2[\ln(l_D/r_g)]^2$$

or $r_g\sim Ze^2/kT_2$.

295 A ROTATORY MAGNETO-MECHANICAL EFFECT IN A LOW-PRESSURE PLASMA.

.L.Granovskii and É.I.Urazkov.

h. eksper. teor. Fiz. (USSR), Vol. 38, No. 4, 1354-5 (April, 1960). n Russian.

An experiment is described which indicates that the gas in the ositive column of a low-pressure gas discharge (A or Ne at 100 to 00 μ Hg) rotates if there is a magnetic field (100 to 800 Oe) parallel o the axis of symmetry. The direction of rotation depends on the irection of the field but not on that of the discharge current. The otation is tentatively attributed to a diffusion effect arising when e concentration gradient is perpendicular to the magnetic field. English translation in: Soviet Physics—JETP (USA), Vol. 11, No. 4, 74 (Oct., 1960)].
C.Penrose

296 THEORY OF PLASMA IN THE PRESENCE OF MAGNETIC FIELDS. J.Friedrich.

. Phys. (Germany), Vol. 160, No. 5, 494-503 (1960). In German.

Based on the Boltzmann equation, a complete theory of stationary cylindrical plasma is obtained, taking into consideration the resence of the self-magnetic field as well as an additional longiudinal magnetic field. The effect of electron—electron interaction s thoroughly included by expansions in terms of Sonine polynomials. he formulae of the current density and heat flow components of -th order approximation explicitly determined here are derived n terms of mean free paths which depend on the directions of ansport as well as of the producing gradient. In the same manner, e corresponding components for a Lorentz plasma are given.

297 INTERACTION OF A BEAM OF CHARGED PARTICLES WITH A PLASMA.

.A.Demirkhanov, A.K.Gevorkov and A.F.Popov.

h. tekh. Fiz. (USSR), Vol. 33, No. 3, 315-19 (March, 1960). Russian.

Investigations made at frequencies of 1000-3000 Mc/s show at on injecting a continuous beam of electrons, faster than those the plasma, longitudinal waves are set up in the plasma. The stribution of intensities of induced frequencies shows a maximum the plasma frequency. In the presence of induced oscillations, m. waves of the same frequencies are observed outside the plasma. ere is good agreement between experiment and theory.
Z.Krasucki

298 THE PROBLEM OF RADIATION FROM PLASMAS. K.G.Emeleus and A.Garscadden.

aturwissenschaften (Germany), Vol. 47, No. 21, 491 (Nov., 1960).

It is suggested that in the various experiments in which plasma scillations have been observed, probes and electrodes have played important (perhaps essential) part in allowing the radiation to ave the plasma.
D.Walsh

299 THE STABILIZATION OF LOCALIZED AND FLYING DROPS OF PLASMA BY ELECTROMAGNETIC WAVES.

V.Yankov.

. tekh. Fiz. (USSR), Vol. 30, No. 9, 1019-23 (Sept., 1960). Russian.

A stability criterion is derived for a drop of plasma contained high-frequency electromagnetic waves, on the assumption that changes in the shape, size, or position of the drop take place slowly. Two examples of stable configurations are exhibited, one with the drop stationary, the other with the drop moving along the axis of a cylindrical waveguide. [English translation in: Soviet Physics—Technical Physics (USA)].
O.Penrose

300 ELECTRIC FIELD DISTRIBUTION IN A DENSE PLASMA. J.L.Jackson.

Phys. of Fluids (USA), Vol. 3, No. 6, 927-31 (Nov.-Dec., 1960).

A calculation is presented of the probability distribution function of the electric field at the centre of an ion or atom in a plasma in the high ion density limit. In this limit, it is possible to take into account rigorously the effect of the Coulomb interactions on the distribution function. The distribution function in the high-density limit is Gaussian. The Coulomb interaction decreases the mean square electric field by the multiplicative factor $[1+\kappa\alpha_0+\frac{1}{3}(\kappa\alpha_0)^2]^{-1}$ where κ is the reciprocal Debye length and α_0 the radius of the ion or atom at whose centre the field is evaluated.

301 LONG-WAVELENGTH BEAM INSTABILITY. M.N.Rosenbluth.

Phys. of Fluids (USA), Vol. 3, No. 6, 932-6 (Nov.-Dec., 1960).

The kinematics of a self-pinched neutralized relativistic stream is developed in the limit of oscillations whose frequency in the rest frame of the beam is low compared to the betatron frequency of oscillation of the particles of the beam. It is shown that in this limit the beam is able to displace itself more or less rigidly giving rise to the possibility of kink-type instabilities depending on its coupling with the external medium. In particular, the case where the beam passes through a low conductivity plasma is considered here. In this case there is a viscous drag when the beam displaces and pulls its magnetic field through the resistive plasma. This leads to an instability of the beam.

302 DYNAMIC STABILIZATION OF A PLASMA COLUMN E.S.Weibel.

Phys. of Fluids (USA), Vol. 3, No. 6, 946-60 (Nov.-Dec., 1960).

A cylindrical plasma column is confined by a magnetic field whose z component is constant while the φ component oscillates sinusoidally. The skin depth is assumed to be negligible so that the boundary can be considered as sharp and the interior of the plasma as field free. The plasma itself is treated as an assembly of noncolliding particles which are specularly reflected at the plasma surface. The oscillating pressure of the applied field causes the plasma surface to execute a small periodic motion independent of φ and z. All other components of the displacement decay in time. Thus the plasma is positively stable against all deformations. For magnetostatic confinement this treatment yields the usual instabilities, but, in contrast to earlier work, the growth rates are bounded as the deformation wavelength approaches zero. This appears to be in better agreement with experiment.

303 PLASMA MOTION ACROSS MAGNETIC FIELDS. G.Schmidt.

Phys. of Fluids (USA), Vol. 3, No. 6, 961-5 (Nov.-Dec., 1960).

The analysis of plasma flow problems in magnetic fields is usually based on a hydromagnetic fluid model. In low-density collisionless plasmas however, the limitations of the applicability of this method are not clearly understood. A simplified self-consistent field method is used, with particle motion considered in the guiding centre approximation. In this case the high "dielectric constant" of the magneto-plasma plays the role of the infinite conductivity of the fluid model. Several experiments are analysed on the basis of this model, and the limitations and shortcoming of the hydromagnetic treatment discussed.

304 CHARGE EXCITATION OF PLASMA MOTION IN A MAGNETIC FIELD. R.A.Pappert.

Phys. of Fluids (USA), Vol. 3, No. 6, 966-72 (Nov.-Dec., 1960).

The wake of a massive point charge traversing a low-density plasma of vanishing ion temperature, in a constant external magnetic field, is investigated by means of linearized Boltzmann theory. The speed of the exciting charge is taken to be less than the root-mean-square thermal speed of the electrons and the electron thermal energy is taken to be much less than the ion energy associated with the ambient flow velocity, that is, the ion flow velocity as seen in a reference frame moving with the external charge. The magnetic field is taken along the direction of motion of the exciting charge. One of the effects of the magnetic field is the production of oscillations of both the charge density and the potential. Over some regions of space the frequency of these oscillations is approximately equal to the ion cyclotron frequency.

305 PLASMA ACCELERATION IN A RADIO-FREQUENCY FIELD GRADIENT.

G.A.Swartz, T.T.Reboul, G.D.Gordon and H.W.Lorber.
Phys. of Fluids (USA), Vol. 3, No. 6, 973-6 (Nov.-Dec., 1960).

Experiments have been performed at 140 Mc/s determine the acceleration of a mercury plasma in a r.f. field gradient. With a maximum r.f. field amplitude of 170 V/cm, a tenuous plasma (of density less than a critical density) was accelerated from 5×10^5 to 25×10^5 cm/sec. A denser plasma (of density greater than the critical density) was decelerated in the same field. These experimental results are consistent with a theory based on energy considerations.

306 SUFFICIENT CONDITIONS OF HYDROMAGNETIC STABILITY OF A DIFFUSE LINEAR PINCH. H.P.Furth.

Phys. of Fluids (USA), Vol. 3, No. 6, 977-81 (Nov.-Dec., 1960).

From the energy principle a sufficient stability condition can be derived that involves a disposable function. The existence of some choice of the disposable function such as to satisfy the sufficient condition is a necessary condition for stability. The disposable function may also be chosen so as to yield sufficient conditions that are not necessary, but that may be useful from the points of view of simplicity and generality. This technique is illustrated for "maximal-force configurations", where the current density is everywhere orthogonal to the magnetic field.

307 STABILIZATION OF PINCH DISCHARGES.

S.A.Colgate and H.P.Furth.
Phys. of Fluids (USA), Vol. 3, No. 6, 982-1000 (Nov.-Dec., 1960).

The hydromagnetic stability properties of "hard-core" pinches are shown to be more favourable than those of conventional "stabilized pinches". Linear "hard-core" pinch experiments with a wide range of configurations show a basic consistency with hydromagnetic theory, but all configurations studied so far become unstable at sufficiently high current densities and low particle densities, even if possessed of theoretical hydromagnetic stability. Pinches with nulls in B_θ tend to be much less stable than those with nulls in B_z. "Inverse stabilized pinches" yield perfectly reproducible magnetic probe traces at power levels several times those at which "stabilized pinches" are unstable. A technique for the study of plasma density distributions is given, based on the propagation of radial compressional waves. The theory of the steady-state pinch is enlarged to include convective effects and is documented by experiment. The role of electrodes is considered, and an anode-cathode asymmetry in instability behaviour is demonstrated for the linear "stabilized pinch". The prospects of stable, high-temperature operation with the toroidal hard-core pinch, or "levitron", are discussed.

308 MAGNETOHYDROSTATIC EQUILIBRIUM FOR PLASMA IN A TORUS TUBE. T.Kihara.

J. Phys. Soc. Japan, Vol. 14, No. 10, 1397-9 (Oct., 1959).

A solution is given of the magnetohydrostatic problem of finding the equilibrium configuration of a plasma in a slightly bending torus tube with circular cross-section. Both the plasma and the tube wall are assumed to be perfectly conducting. The ratio of the tube radius to the radius of curvature, R, of the tube axis is assumed to be so small that its square is negligible. The method is an application of a perturbed cylindrical coordinate system, in which the line element ds is given by

$$ds^2 = (1 - \xi R^{-1} r \cos\theta)^2 dr^2 + (1 - \eta R^{-1} r \cos\theta)^2 r^2 d\theta^2 + (1 + R^{-1} r \cos\theta)^2 dz^2,$$

ξ and η being functions of r satisfying $\xi = d(r\eta)/dr$. A result is the following. If an axially symmetric plasma cylinder with the material pressure monotonically decreasing towards the plasma surface is slightly bent into a torus, then two isobaric surfaces are closer in the more distant part from the torus axis than in the less distant part.

309 INVESTIGATION OF A TOROIDAL DISCHARGE IN A RAPIDLY CHANGING LONGITUDINAL MAGNETIC FIELD. D.P.Ivanov and V.D.Kirillov.

Dokl. Akad. Nauk SSSR, Vol. 133, No. 4, 793-6 (Aug. 1, 1960). In Russian.

An experiment is described where a toroidal discharge takes place in an oscillating longitudinal magnetic field. The longitudinal and azimuthal magnetic fields and the longitudinal current and electric field were measured,and are exhibited as functions of time by oscillograms. The part of the cycle where the longitudinal magnetic fields inside and outside the discharge are oppositely directed is given special attention, both experimentally and theoretically.

O.Penrose

310 SUPERFAST PINCH EXPERIMENT.

V.Josephson.
Phys. of Fluids (USA), Vol. 3, No. 6, 1001-7 (Nov.-Dec., 1960).

An assembly designed to accelerate deuterons to about 10 keV by means of a radially converging magnetic piston has been constructed and tested. The assembly operates with 300 kV on the energy storage condenser, the ringing frequency is 18 Mc/s and present operation uses hydrogen gas at 50 μ. Both slow and fast pinches have been observed, the former being possibly thermal shock waves, and the latter possibly being associated with inward motion of the plasma sheath.

311 THE PINCH EFFECT.

S.K.Trehan.
Rev. Mexicana Fis., Vol. 8, No. 4, 255-72 (1959).

This article reviews recent work on the effect of magnetic constriction in gaseous plasmas. After a general discussion of the phenomena, the criteria are obtained for the establishment of a constrained plasma column, using the formulism of Marshall and Rosenbluth.

312 KINEMATICS OF OHMIC HEATED PLASMAS IN THE B-1 STELLARATOR.

W.Bernstein, A.Z.Kranz and F.Tenney.
Phys. of Fluids (USA), Vol. 3, No. 6, 1019-25 (Nov.-Dec., 1960).

A kinetic description of the B-1 stellarator plasma during various stages of ohmic heating discharges is presented. It is shown that for specific ranges of plasma current, for a given confining field, the plasma assumes a shape which has an azimuthal distribution of the form exp Im(θ). It is further shown that the plasma column rotates at high velocity while the distortion is present. The possible relationship between these current ranges and the predictions of hydromagnetic instability theory is considered.

313 MEASUREMENT OF PLASMA TEMPERATURE AND ELECTRON DENSITY.

K.Murakawa and S.Mizuno-Hashimoto.
J. Phys. Soc. Japan, Vol. 14, No. 9, 1235-42 (Sept., 1959).

The plasma was obtained by discharging a capacitor through a Geisler tube containing neon. The wavelength of NeI 5852 A emitted was compared with that of the same line emitted from an arc discharge, the comparison being made with a Fabry—Perot etalon. A red shift of the line by spark discharge was detected. From the amount of the shift the half-value width contributed by the ionic field and electrons was calculated by Lindholm's formula. Subtracting this (vertorially) from the observed half-value width, the width contributed by the Doppler effect alone was obtained, and the plasma temperature calculated. From the line profiles of Hγ and NeI 4715 Holtsmark's normal field strength F_n was obtained, and therefore the electron density could be deduced. In the present example the mean plasma temperature was $T = 6 \times 10^{3}$ °K, and the mean electron density $N = 1 \times 10^{10}$ cm^{-3}.

Plasma Oscillations

314 ION WAVE INSTABILITIES.

I.B.Bernstein and R.M.Kulsrud.
Phys. of Fluids (USA), Vol. 3, No. 6, 937-45 (Nov.-Dec., 1960).

The dispersion relation for electrostatic oscillations in a magnetic field is derived on the basis of the Boltzmann equation for arbitrary velocity distributions and for propagation in an arbitrary direction under the following restrictions: (1) the thermal velocities of the particles and the phase velocity of the wave are small compared to those of light; (2) the component of the wave vector k perpendicular to the magnetic field is small compared to the reciprocal of the gyration radius of an ion at the larger of the mean ion, and electron thermal, energies; (3) the magnetic field B is uniform. The dispersion relation is formally identical with that for electrostatic oscillations in the absence of a magnetic field. The dispersion relation is examined for stability under the further restrictions that: (4) the mean thermal energy of the ions is small compared to that of the electrons; (5) the electron distribution function for the component of the velocity v along B has a single maximum. It is found that a very small shift along B of this maximum relative to the ions leads to an unstable ion oscillation. The growth rates and frequencies of these oscillations are determined; their possible applications are discussed. Some further results on the "two stream" instability are given.

315 THE PROPAGATION OF WAVES IN A PLASMA. R.Lüst.
ortschr. Phys. (Germany), Vol. 7, No. 9, 503-58 (1959). In German.

Survey article with 52 references. The main topics discussed re Alfvén waves, plasma oscillations, the propagation of electro-agnetic waves, finite amplitude effects and hydromagnetic shocks, nd effects of anisotropy of the pressure. H.N.V.Temperley

ELECTRON EMISSION
ELECTRON BEAMS

316 SOME LAWS GOVERNING FIELD EMISSION OF ELECTRONS FROM SEMICONDUCTORS.
.I.Klimin, B.N.Sedykh and I.L.Sokol'skaya.
iz. tverdogo Tela (USSR), Vol. 2, No. 8, 1851-6 (Aug., 1960).
Russian.

The field-emission current from germanium was studied as a inction of the applied field and temperature. It was found that the emperature dependence of the current was governed by the electron ensity at the surface of germanium; this density was enhanced by enetration of the applied field. The results agreed with the theory field emission by semiconductors for the case of weak influence the surface states. A.Tybulewicz

317 THE THEORY OF THE EXTERNAL EMISSION OF HOT ELECTRONS FROM SEMICONDUCTORS.
h.M.Kogan and V.B.Sandomirskii.
iz. tverdogo Tela (USSR), Vol. 2, No. 10, 2570-8 (Oct., 1960).
Russian.

The emission of electrons from a semiconductor in an electric eld is considered, taking shock ionization and interaction of the arrier current with acoustic and optical phonons into account. English translation in: Soviet Physics—Solid State (USA)].
R.F.S.Hearmon

318 DOPING INFLUENCES ON ACTIVATOR DIFFUSION IN OXIDE-COATED CATHODE NICKEL. H.Mizuno.
Phys. Soc. Japan, Vol. 14, No. 10, 1295-1301 (Oct., 1959).

The influences of doping on the minute activator diffusion in ide-coated cathode nickel were measured by a method similar to alin and Martin's and the following conclusions were derived; the influences of doping on the activator diffusion in oxide-coated ckel are significant, (2) as the Mn, Fe, or Si content in oxide-ated cathode nickel increases, the diffusion coefficient of Mg in se nickel decreases monotonously, and (3) as the Mg content in ide-coated cathode nickel increases, the diffusion coefficient of increases monotonously.

319 PHOTOELECTRIC EMISSION FROM MERCURY TELLURIDE. O.M.Sorokin.
iz. tverdogo Tela (USSR), Vol. 2, No. 10, 2349-53 (Oct., 1960).
Russian.

Emission intensity of HgTe had a vague step at the photon ergy of 4.0 eV and rose sharply at 4.8 eV. Two photo-electron ergy groups were observed at photon energies of 4.7-5.1 eV. he photoelectric work function φ_p rose monotonically with photon ergy $h\nu$: $\varphi_p = 4.00$ eV at $h\nu = 4.70$ eV and $\varphi_p = 4.85$ eV at $h\nu = 6.40$ eV. The photoelectric work function was smaller than the ermionic work function ($\varphi_t = 4.5$ eV) at $h\nu < 5.00$ eV. It was con-uded that HgTe was a semiconductor with an energy gap of 0.45 eV. nglish translation in: Soviet Physics—Solid state (USA)].
A.Tybulewicz

320 STUDIES OF AUGER ELECTRONS EJECTED FROM GERMANIUM BY SLOWLY MOVING POSITIVE IONS.
D.Hagstrum.
Phys. Chem. Solids (GB), Vol. 14, 33-6 (July, 1960).

Measurements have been made of total yield and kinetic energy tribution of Auger electrons ejected from a germanium surface singly charged noble gas ions. By this means, surface changes e been monitored during procedures designed to clean the surface. bombardment yielded a reproducible surface which showed the ger characteristics to be expected for the clean surface. Heating lower temperatures for days and for a total of about 3 hr at 70° K (40° below the melting point) prior to any sputtering only tially cleaned the surface. From the kinetic energy distribution he Auger electrons some of the principal characteristics of the state density function in the valence band of germanium have been determined.

321 ON THE WORKING MECHANISM OF THIN LAYERS IN PICK-UP TUBES. A.Fryszman.
Bull. Acad. Polon. Sci. Ser. Sci. math. astron. phys. (Poland), Vol. 8, No. 12, 733-40 (1959).

A mathematical analysis is given of the behaviour of a thin semiconducting layer subjected to periodic electron bombardment, showing a dependence on the form of the secondary electron emission characteristic of the semiconductor. The treatment has special reference to the mechanism of operation of photosensitive layers in Vidicon tubes. C.H.B.Mee

322 INTERACTION OF ELECTRONS WITH THE FIELD OF H_{01} MODE IN A CIRCULAR WAVEGUIDE.
I.A.Gilinskii.
Dokl. Akad. Nauk SSSR, Vol. 134, No. 5, 1055-7 (Oct. 11, 1960).
In Russian.

Considers energy transfer due to the interaction of a spiral electron beam with H_{01} wave, which is a non-linear effect. Constructs the Hamiltonian of the system and evaluates the energy transfer coefficient which is greatest for non-axial beams.
J.K.Skwirzynski

323 IMAGE FORMATION BY ELECTRON BOMBARDMENT OF METAL TARGETS. E.H.Hirsch.
Brit. J. appl. Phys., Vol. 11, No. 12, 547-50 (Dec., 1960).

In a demountable vacuum system a latent image is formed of a region on a metal target which has been subjected to very weak electron bombardment. This image can be made visible by electroplating the target in a copper sulphate solution. An experimental investigation of the influence of bombarding current, electron energy and target temperature is presented. The results suggest that the effect is due to the formation of a monolayer of hydrocarbon contamination, the build-up of which is catalytically accelerated by the metal target. The effect takes place even with 5 V electrons and can be used to obtain permanent visual records of slow electron beam focal spots.

324 MULTIBEAM CATHODE-RAY TUBE AIDS SHOCK-WAVE STUDIES. L.Mancebo.
Electronics (USA), Vol. 33, No. 35, 51-3 (Aug. 26, 1960).

39 electron beams from 39 separate cathode-grid assemblies, mounted on a concave dish, are focussed by a corrected spherical lens on to a cross-over situated between a pair of deflecting plates. The 39 traces on the phosphor screen can be used for one-shot, fast-transient work, when amplitudes are representable as time durations. Some details of construction, size and performance (time resolution: 1 in 1000) are given as well as an application to the study of an exploding gas. B.Meltzer

325 THE CONSTRUCTION OF SIMPLE APPARATUS FOR INVESTIGATIONS WITH THE ELECTRON MIRROR.
H.Bethge, J.Hellgardt and J.Heydenreich.
Exper. Tech. der Phys. (Germany), Vol. 8, No. 2, 49-61 (1960).
In German.

An electron mirror system was developed in which the imaging beam returns from the mirror along the same path as the incident beam, which issues through a hole in the fluorescent screen on which the image is formed. Two versions are described: an experimental apparatus of glass, and a more elaborate instrument of metal intended for routine investigations. They are usually operated at 5 kV and provide magnifications of up to 275. As applications of the method, micrographs are given of the surface of an optical diffraction grating and of a cleavage face of sodium chloride shadowcast with silver. The method of calculating electron paths at the mirror is described, and some consideration is given to the origin of contrast in the electron image. V.E.Cosslett

326 INVESTIGATION OF THE SENSITIVITY OF THE ELECTRON MIRROR FOR IMAGING POTENTIAL DISTRIBUTIONS. H.Bethge and J.Heydenreich.
Exper. Tech. der Phys. (Germany), Vol. 8, No. 2, 61-5 (1960). In German.

The electron mirror described in the preceding abstract was used to investigate quantitatively the distribution of potential across surfaces of metals and semiconductors. Tests specimens were made in the form of resistive steps by evaporating pure germanium, or germanium mixed with aluminium, on to films of silver or of germanium on glass. Examples are shown of the effect on the electron image of such a surface when a potential difference is applied across it. Calibration curves show that reliable deductions can be made so long as the potential step lies in the range between 1.1:1 and about 100:1, for the particular arrangement investigated.

V.E.Cosslett

327 ON THE FORMATION OF ELECTRON-OPTICAL CONSTRAST IN THE OBSERVATION OF "FIELD SPOTS" IN EMITTING SURFACES.

G.V.Spivak, I.A.Pryamkova and N.N.Sedov.
Izv. Akad. Nauk SSSR, Ser. fiz., Vol. 24, No. 6, 640-6 (1960).
In Russian.

"Cathode electronics Conference" Moscow, 1959 (See Abstr. 17022 of 1960). Discusses the factors responsible for image formation in electron emission microscopes including those using the specimen as an element in an electron mirror. Constrast may arise from irregularities of the surface, from local variations of surface charge or from local differences in work function or from these combined. Examples are given of such images and a special emission microscope is described in which the specimen, possibly an oxide coated cathode, can be caused to emit either by heating or by irradiation with ultraviolet light.

A.E.I. Research Laboratory

328 APPLICATION OF HIGHER ORDER BORN APPROXIMATION TO MULTIPLE ELASTIC SCATTERING OF ELECTRONS BY CRYSTALS.

K.Fujiwara.
J. Phys. Soc. Japan, Vol. 14, No. 11, 1513-24 (Nov., 1959).

The calculation of Artmann (quoted by Raether, Handbuch der Physik, Vol. 32, 475 (1957)) for the wave function of electrons in a crystal due to the first order Born approximation is extended to higher order approximations by iterated integrations. As a result, Cowley and Moodie's formula (Abstr. 7655 of 1959) for the multiple elastic scattering of electrons by a crystal is re-obtained in an improved form. The convergency of the higher order terms is illustrated by the numerical calculations on two simple examples. An elementary application is also made to the moiré patterns in electronmicrographs.

329 SMALL-ANGLE COHERENT SCATTERING OF 500 keV ELECTRONS.

I.Berkes and I.Demeter.
Acta phys. Hungar, Vol. 12, No. 2, 99-101 (1960).

The scattering of 502 keV electrons on thin Al and Ag foils was investigated. The electron energy was determined by measuring the accelerating voltage by means of a rotating field meter. The value of the wavelengths calculated from the accelerating voltage and measured from the diameter of diffraction rings agree within the error of measurement of ±1.5%.

330 ENERGY DISSIPATION BY FAST ELECTRONS.

L.V.Spencer.
Nat. Bur. Stand. Monogr. I (USA), 1-70 (1959).

Tabulations are given of the energy dissipated at different distances from monoenergetic electron sources, for plane perpendicular and point isotropic sources. A summary of the theoretical methods and data utilized, and a table of spatial moments are also included.

331 ON THE TEMPERATURE OF AN OBJECT IRRADIATED WITH ELECTRONS.

S.Yamaguchi.
J. appl. Phys. (USA), Vol. 31, No. 10, 1825-6 (Oct., 1960).

Describes an experiment in which small particles of Invar were attached to the edge of a magnetized razor blade and examined by electron diffraction with transmitted electrons. The magnetic induction of the specimen causes eccentricity of the rings. The electrons heat up the specimen causing a change in magnetic properties. In particular the attainment of the Curie point temperature can be clearly seen from the diffraction pattern.

A.E.I.Research Laboratory

332 ON THE TEMPERATURE RISE BY ELECTRON BOMBARDMENT.

S.Yamaguchi.
Naturwissenschaften (Germany), Vol. 47, No. 13, 302 (1960).
In German.

Describes a method for estimating temperature rise caused by electron bombardment. Small filings of Invar (64% Fe–36% Ni) are picked up on a magnetized razor blade which in turn is mounted in the specimen stage of a diffraction camera. When the Curie point of Invar is reached (120°C) the particles fall off the blade. A more refined method is to observe the eccentricity of the diffraction rings caused by magnetization of the Invar. The eccentricity will disappear as the Curie point is approached.

A.E.I. Research Laboratory

ION EMISSION . ION BEAMS

333 OUTPUT SYSTEMS FOR TIME-OF-FLIGHT MASS SPECTROMETERS.

J.F.Betts, E.H.Paufve, and W.C.Wiley.
Appl. Spectrosc. (USA), Vol. 14, No. 5, 119-23 (1960).

The three major types of output system for time-of-flight mass spectrometers are described and their applications discussed. An oscilloscope output system is used to obtain rapid information, the accuracy being limited to the accuracy of the oscilloscope employed. For very small mass peaks, the accuracy degenerates to zero. An analogue output system is considered to be the most useful and versatile output system. It uses a selective gated input to measure simultaneously the areas under several mass peaks. Using this type of output, spectral patterns which are normally generated in several miscrosec can be recorded on recorders with a response of 100 c/s or less. When the average number of ions per mass peak per mass spectrum is considerably less than one, a counter circuit (digital output system) can be used to sum the ions which occur in specific mass peaks. Several mass peaks can be counted simultaneously.

334 ADJUSTMENT OF DOUBLE FOCUSSING MASS SPECTROGRAPHS.

F.Everling.
Nuovo Cimento Suppl. (Italy), Vol. 6, No. 1, 274-9 (1957).

An outline of a calculation is given of the dependence of the sharpness of focus in a double focusing mass spectrograph on numerous geometrical factors. Conclusions are reached as to which of these quantities should be made variable in practice and the best method of making the adjustment.

R.E.Meads

335 RELATION BETWEEN ION ENERGY DISTRIBUTION FUNCTION AND THE FORM OF LINES IN THE MASS-SPECTRUM OF A RADIO-FREQUENCY MASS-SPECTROMETER.

E.M.Kuchkov.
Zh. tekh. Fiz. (USSR), Vol. 30, No. 8, 948-53 (Aug., 1960). In Russian.

The effect of initial ion velocity spread on the resolution of r.f. mass spectrometers is investigated theoretically. [English translation in Soviet Physics —Technical Physics (USA)].

S.Chomet

336 RANGES OF 7.5 TO 52 keV H_2^+, D_2^+, He^+, AND Ne^+ IONS IN QUARTZ.

R.L.Hines.
Phys. Rev. (USA), Vol. 120, No. 5, 1626-30 (Dec. 1, 1960).

Experimental values of penetration depths of positive ions in quartz obtained from measurements of reflection coefficient versus wavelength are compared with theoretical predictions. Measurements of the change in refractive index of quartz as a function of the energy dissipated per unit volume are shown to give experimental values for the ratio of energy loss due to displacement collisions per unit thickness to the energy loss due to ionization per unit thickness. The energy loss due to displacement collisions per unit thickness agrees with theoretical predictions. From the experimental values of energy loss due to ionization, it is found that the cross-sections for scattering of valence electrons by the field of the incident atoms are an order of magnitude larger than the geometric cross-sections.

337 ENERGY LOSS AND EFFECTIVE CHARGE OF HEAVY IONS IN ALUMINUM.

L.C.Northcliffe.
Phys. Rev. (USA), Vol. 120, No. 5, 1744-57 (Dec. 1, 1960).

Heavy-ion beams of fixed initial energy ($E^0/m \cong 10$ MeV/a.m.u.) are passed through aluminium absorbers of known thickness, and the emergent ions are analysed by means of a magnetic spectrograph to determine their charge and energy distributions. Accurate measurements of the mean emergent ion energy as a function of absorber thickness are reported for beams of He^4, B^{10}, B^{11}, C^{12}, N^{14}, O^{16}, F^{19}, and Ne^{20} ions with emergent energies in the range $10 > E/m > > 1$ MeV/a.m.u. The results can be interpreted as measurements of the range–energy relation for heavy ions. While the absolute accuracy of the range measurements is approximately ±1 mg/cm², the range difference $R(E^0)-R(E)$ is measured (as a function of E) with a typical accuracy of ±0.1 mg/cm². In the analysis the shape of the heavy-ion range–energy curve is compared with the accurately known shape of the proton range–energy curve (using the conversion factor $\Delta R = mZ_p^2(m_pZ^2)^{-1}\Delta R_p$) and the differences in shape are attributed to deviations of the effective charge of the ion from its nuclear charge. No detectable difference is found between the shape of the range–energy curve for He^4 ions and for protons. For heavier ions, deviations in the curve shape do occur. A simple empirical formula is found for the effective charge of an ion

a function of its velocity which is consistent with the deviations of
e observed range—energy curves and presumably can be used to
edict the range—energy curves for ions not investigated experi-
entally. By an independent analysis of the spectrograph data the
uilibrium distribution of charge states in the O^{16} beam is deter-
ned as a function of emergent beam energy. The effective charge
plied by the charge state distribution is found to be consistent
th the effective charge as given by the empirical formula.

338

ENERGY LOSS MEASUREMENTS FOR HEAVY IONS IN MYLAR AND POLYETHYLENE.

E.Schambra, A.M.Rauth and L.C.Northcliffe.
ys. Rev. (USA), Vol. 120, No. 5, 1758-61 (Dec. 1, 1960).

The energy loss of C^{12}, O^{16}, and Ne^{20} ions in passage through
ls of Mylar and polyethylene was investigated for incident ion
ergies of 10 MeV/a.m.u. and emergent ion energies in the region
m 10 to 1 MeV/a.m.u. The ion energies were measured with a
gnetic spectrograph. The variation of emergent ion energy with
sorber thickness (essentially the range—energy relation) is re-
rted and compared with similar results for the same ions in
minium. Within experimental error, the curves for Mylar and
lyethylene differ from those for aluminium only in the scale of
sorber thickness. For the same energy loss, the ratio of absorber
cknesses (in mg/cm^2) is 0.783 for Mylar to aluminium, and 0.692
polyethylene to aluminium.

PARTICLE ACCELERATORS

339

ENGINEERING METHODS FOR ELECTRON-BEAM PROCESSING. D.A.Trageser.

clear Instrum. and Methods (Internat.), Vol. 6, No. 1, 26-32
ec., 1959).

Improved economics for electron processing depend upon the
velopment of new accelerators and better engineering methods for
ir use. The scope of future processing accelerators embraces a
nge of 0.5 MeV to 15 MeV in energy, and 1 kW to 1000 kW in
wer. New developments include (1) accelerators in the 0.5 to
MeV range, with power outputs of 10 to 100 kW, and (2) a series of
ear accelerators in the 3 to 9 MeV range at about 5 kW, with
xibility of energy adjustment at maximum power. Longer-lived
mponents are also under development. The shielding for a pro-
ssing installation can be minimized by the use of a shallow pit with
al shielding around the point of beam use. Examples of this
sign are shown for processing film or wire, and for conveyorized
terials. Magnetic systems can be used to change beam geometry
ernal to the accelerator. A beam inverter has been developed so
t a product can be bombarded from both sides simultaneously with
accelerator. An intermittent filter has also been tested. The
iciency of double bombardment is thereby increased to about 80%,
cause the uniformity of dose is greatly improved. The optimum
er for a 2 MeV beam is about 0.25 g. cm^{-2} thick used in $33\frac{1}{3}$%
erruption of the beam. The availability of new metal alloys in the
m of thin sheets and thinwalled tubes makes possible the develop-
nt of new techniques for irradiating fluids under elevated pressure
temperature in continuous flow. Scanned electron beams at 1 or
MeV can treat liquids in flanged reactors with thin windows. This
l permit pressures up to about 40 atmospheres, with a 90% beam-
efficiency. Tubular reactors permit pressures of 75 atmospheres
h a 50% efficiency.

340

ELECTRON OPTICAL CONSTRUCTION OF INHOMOGENEOUS ACCELERATING TUBES. E.Koltay.

clear Instrum. and Methods (Internat.), Vol. 6, No. 1, 45-9
ec., 1959). In German.

The numerical application of the polygon method given by Gans
37) proved to be a simple and reliable procedure for the design
the accelerating tube with inhomogeneous field of the high voltage
nerators. Calculations were made using this method in connection
th the accelerating tube of a Van de Graaff generator of 2 MV
ed voltage. For the axial potential the data given by Kirkpatrick
d Beckerley (Abstr. 864 of 1936) was used.

341

T.I.F.R. VAN DE GRAAFF ACCELERATOR.

K.A.George, A.S.Divatia, M.K.Mehta, S.S.Bhave,
.S.Deshpande, R. and T.G.Varghese.
roc. Indian Acad. Sci. A, Vol. 50, No. 3, 175-82 (Sept., 1959).

The air-insulated Van de Graaff accelerator at the Tata Institute of Fundamental Research, Bombay, is described. It produces 10 μA of protons and singly ionized hydrogen molecules at 300 keV. The energy attainable is limited by the surrounding clearance to neighbouring walls and the prevalent high humidity.

A.E.I. Research Laboratory

342

WITHDRAWAL OF A BEAM OF ACCELERATED ELECTRONS OUT OF THE CHAMBER OF A CYCLICAL ACCELERATOR WITHOUT THE APPLICATION OF A LEAD-OUT DEVICE. A.A.Vorobjev and L.S.Sokolov.

Nuclear Instrum. and Methods (Internat.), Vol. 5, No. 5, 337-8 (1959).

The method depends on exciting oscillations, at a harmonic of the circulation frequency, in the electron orbit by a local disturbance of the magnetic field of the betatron. The necessary equation and solution are given. A 10 MeV electron beam of average current 6×10^{-10} A was extracted experimentally with 75% efficiency.

J.W.Sturgess

343

ACCELERATORS WITH STABLE OSCULATING PARTICLE ORBITS. E.M.Moroz.

Atomnaya Energiya (USSR), Vol. 4, No. 3, 238 (1958). In Russian.
English translation in: Reactor Science (GB), Vol. 10, No. 3-4, 165-9 (Sept., 1959).

A new class of accelerators is discussed which have a magnetic system consisting of several sectors separated by gaps in which the field is very weak. This magnetic system has two perpendicular planes of symmetry but has no axes or centre of symmetry. All the particle orbits pass through a common point at which the accelerating element, a cavity resonator, is placed. The stability of the particle motion is ensured by the action of the fringe fields of the sectors. The magnet system here proposed can be used in cyclotrons and microtrons. The advantages of this new class of accelerator are an increase in beam intensity and a reduction in power consumption, the possibility of extracting particles from any orbit and the possibility of varying the energy of the extracted particles within wide limits.

344

STARTING UP OF THE CYCLOTRON WITH SPACE VARIATION OF THE MAGNETIC FIELD.

V.I.Danilov, Yu.N.Denisov, V.P.Dmitrievsky, V.P.Dzelepov, A.A.Glazov, V.V.Kolga, A.A.Kropin, Lu Ne-Chuan, V.S.Rybalko, L.A.Sarkisyan, A.L.Savenkov, D.P.Vasilevskaya, B.I.Zamolodchikov and N.L.Zaplatin.

Nuclear Instrum and Methods (Internat.), Vol. 5, No. 5, 335-6 (1959).

Discusses the rise in the mean magnetic field for a spiral-sector cyclotron which is needed to eliminate non-linear resonance effects at the centre. The vertical stability is also considered. The method of shimming is described. The cyclotron gave 12 MeV deuterons and 24 MeV α-particles with a minimum dee voltage of 8 kV and a maximum of 40 kV. The internal beam intensity was 1 μA.

J.W.Sturgess

345

THE MAXIMUM ADMISSIBLE RADIAL DECREASE OF THE MAGNETIC FIELD IN THE CYCLOTRON.

A.Valeriu.

Stud. Cercetari Fiz. (Roumania), Vol. 10, No. 2, 329-43 (1959). In Roumanian.

The variation of the ion phase during the acceleration process in the cyclotron was computed. Three methods of computation were used and compared (a graphical method, an analytical method and a method using the electronic digital computer CIFA-1). A simple formula was derived to determine the maximum admissible radial decrease of the magnetic field. The results obtained were compared to the experimental ones.

346

INTERNAL TARGET FOR A BETATRON.

H.Morinaga and T.Kuroyanagi.

Nuclear Instrum. and Methods (Internat.), Vol. 6, No. 1, 66-71 (Dec., 1959).

Internal bombarding technique to produce high specific activity on small samples being used for 25 MeV betatron at Tohoku University is described. The samples are placed inside the doughnut at the end of a blind cylinder inserted from outside; thus samples are bombarded under one atmosphere, just behind the bremsstrahlung target where the X-ray density is extremely high. Design and operational characteristics as well as some examples of its application are presented. More than 1 millicurie of Cu^{62} was produced and the specific activity was 500 times that produced by external bombardment.

347 EXPERIMENTAL INVESTIGATION OF THE PROFILE OF A BETATRON MAGNET. L.Šipek.
Exper. Tech. der Phys (Germany), Vol. 8, No. 3, 103-12 (1960).
In German.

Describes magnetic field measurements in a model of a 15 MeV betatron magnet with a view to determining the best profile. The model was made from transformer sheet. The author concludes that this experimental method is considerably more accurate than any known analytical procedure and less tedious than a difference method. A.E.I. Research Laboratory

348 AZIMUTHAL INSTABILITIES OF CIRCULATING CURRENTS. I.M.Samoilov and A.A.Sokolov.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 2(8), 257-9 (Aug., 1959).
In Russian.

Experimental data are presented which indicate that circulating currents are unstable and break up into clusters equally spaced with respect to the azimuth. Within these clusters conditions exist which are suitable for the appearance of peculiar radial-phase oscillations. A result is that, in a collision with the injector or chamber wall, effective capture of the electrons takes place in betatron-type apparatus. [English translation in: Soviet Physics—JETP (USA)].

349 INTERACTION OF TWO CONSECUTIVELY INJECTED TURNS IN A CIRCULAR ACCELERATOR. A.Nakach.
C.R. Acad. Sci. (France), Vol. 251, No. 17, 1777-8 (Oct. 24, 1960).
In French.

The beam intensity in a synchrotron cannot reach its theoretical maximum because two pulses injected consecutively interact. Experimentally one beam loses 20% of its intensity by being repelled to the inflector plate. Theoretical calculations give results in agreement with experiment. J.W.Sturgess

350 VACUUM IN THE SACLAY PROTON-SYNCHROTRON. F.Prevot and R. le Quinio.
Vide (France), Vol. 14, 197-213 (July-Aug., 1959).
In French and English.

A comprehensive account of the vacuum system is given. This includes discussion on the materials and methods of construction of the chamber, the calculation of the pumping speed and the number of pumps required, the performance of the system in practice and an outline of the control system. J.W.Sturgess

MAGNETISM

(The magnetic properties of solids are included under Solid-State Physics; similarly for Liquid State and Gaseous State)

351 APPARATUS DRAWINGS PROJECT. REPORT NUMBER 12. HALL EFFECT MAGNET. R.G.Marcley.
Amer. J. Phys., Vol. 29, No. 1, 29-31 (Jan., 1961).

A small electromagnet designed for use with an InSb Hall effect device is described. A coil current of 2.3 A produces a field of 3 kG across a 0.56 cm gap. The field is uniform to within 10% over an area 1.5 × 1.5 cm. Fields high enough for use with a Ge sample are practical.

EXPERIMENTAL INVESTIGATION OF THE PROFILE OF A BETRATRON MAGNET. See Abstr. 347

352 VIBRATING REED MAGNETOMETER. D.C.Doughty and P.Mossman.
J. sci. Instrum. (GB), Vol. 37, No. 12, 471-4 (Dec., 1960).

This instrument is a development of the pendulum magnetometer for the measurement of saturation magnetization: it has been found especially useful for exploratory work on new materials, since the test samples it requires are small and of simple shape. The specimen is attached to the end of a flat non-magnetic spring, maintained in continuous vibration in a non-uniform magnetic field: by observing the resonant frequency with and without the field, the magnetization can be calculated by comparison with a reference sample. Accuracies of about 1% can be obtained on materials with specific magnetizations of 50 e.m.u., while the lower limit of usefulness of the instrument is determined primarily by the accuracy required. The device is robust, inexpensive to construct and, in its present form, may be used from room temperature up to 400° C.

SOME PRELIMINARY RESULTS OF THE PIONEER V MAGNETOMETER EXPERIMENT. See Abstr. 21317 of 1960.

353 THE EXPERIMENTAL SOLUTION OF THE DIRECT MAGNETIC PROBLEM. D.Zidarov.
C.R. Acad. Bulg. Sci., Vol. 12, No. 5, 403-5 (Sept.-Oct., 1959).
In German.

Describes the measurement of the magnetic field near a ferromagnetic which is magnetized by the passage of a.c. through a Helmholtz pair. R.Parker

ELECTROMAGNETISM MAGNETOHYDRODYNAMICS

354 AN UPPER LIMIT OF ELECTRICAL AND MAGNETIC INDUCTION IN MEDIA WITH ELECTROMAGNETIC HEREDITY [MEMORY]. H.Rosman and A.Braier.
Bull. Inst. Politeh. Iasi (Roumania), Vol. 5 (IX), No. 3-4, 195-8 (1959). In Roumanian.

The limit is determined theoretically for induction in electromagnetic fields, with permanent harmonic regime, the propagating medium having ferromagnetic or ferroelectric properties. The instantaneous value of electrical induction is given by

$$d = \epsilon \exp(-\delta t) E \sin \omega t + \epsilon_{10} E \int_0^t f(t-\tau) \exp(-\delta t) \sin \omega\tau \, d\tau$$

and if one considers that the memory function is limited in modular form the expression below, for the upper limit of electrical induction results:

$$D_{\mathrm{lim}} = \left[\epsilon + \frac{\omega\epsilon_{10}}{\omega^2+\delta^2} \cdot \coth\left(\frac{\pi\delta}{2\omega}\right)\right] E = \epsilon_{\mathrm{lim}} E.$$

An analogous expression can be obtained for the upper limit of magnetic induction. 7 references. A.Reiss

355 THE MAGNETOGRAVITATIONAL INSTABILITY OF AN INFINITE COMPRESSIBLE CYLINDER. THE FORMULATION OF THE LOCAL INSTABILITY CONDITION. A.G.Pacholczyk.
Atti. Accad. Sci. Torino I (Italy), Vol. 94, No. 4a, 521-32 (1959-60).

The instability of such a cylinder is considered in the case of a magnetic field parallel to the axis of the system. A solution to the fundamental equations is found in the form of convergent series for two cases: close to and at a distance from the axis. The condition for local instability is determined for a uniform field, and for a field proportional to the density of the medium. A.H.Gabriel

356 A PROBLEM CONCERNING A PISTON IN MAGNETOHYDRODYNAMICS. A.A.Barmin and V.V.Gogosov.
Dokl. Akad. Nauk SSSR, Vol. 134, No. 5, 1041-3 (Oct. 11, 1960). In Russian.

This note treats the flow produced when a plane piston moves with constant velocity into, or away from a perfectly conducting non-viscous ideal gas which is initially uniform and contains a uniform magnetic field. In general, the gas will contain a fast shock or rarefaction wave, an Alfvén shock, and a slow shock or rarefaction wave; there may also be a vacuum in front of the piston. An analysis of the hodograph space is used to determine which piston velocities lead to which of the various combinations of wave types. O.Penrose

357 TWO-DIMENSIONAL STOKES FLOW OF AN ELECTRICALLY CONDUCTING FLUID IN A UNIFORM MAGNETIC FIELD. H.Yosinobu and T.Kakutani.
J. Phys. Soc. Japan, Vol. 14, No. 10, 1433-44 (Oct., 1959).

Detailed calculation is carried out for the viscous flow past a circular cylinder in two cases: one in a parallel magnetic field and the other in a transverse magnetic field. The expansion formulae for the drag per unit span of the cylinder are obtained in terms of the Hartmann number in each case.

358 A NOTE ON FORCE-FREE FIELDS. P.Ramamoorthy and B.B.Chakraborty.
Proc. Nat. Inst. Sci. India A, Vol. 25, No. 6, 388-93 (Nov., 1959).

A self-gravitating cylindrical mass of compressible fluid having infinite conductivity is considered. Initially it is supposed to be in equilibrium under the action of its gravity, an axi-symmetrical magnetic field and an external gas pressure. The purpose of the

per is to find the displacements $\xi = \{0, 0, \zeta(\omega), \phi\}$, which would
nder the magnetic field force-free preserving the hydrostatic
uilibrium of the mass. The corresponding changes in the magnetic
ergy per unit length of the cylinder and the pressure distributions
two particular cases are calculated.

359 ON THE LINEAR BEHAVIOUR OF LARGE-AMPLITUDE MAGNETOHYDRODYNAMIC WAVES.
hmoys and E.Mishkin.
ys. of Fluids (USA), Vol. 3, No. 4, 661-2 (July-Aug., 1960).
Magnetohydrodynamic waves propagated parallel to the
gnetic field in an incompressible fluid with finite conductivity
shown to be represented by a system of linear equations. Under
se conditions, large amplitude waves will conform to the theories
eady stated for small disturbances. A.H.Gabriel

360 THE PERMANENT STRUCTURE OF SHOCK WAVES WITH JOULE DISSIPATION. V.A.Belokon'.
. eksper. teor. Fiz. (USSR), Vol. 36, No. 4, 1316-17 (April, 1959).
Russian. English translation in: Soviet Physics—JETP (USA),
l. 36(9), No. 4, 932-3 (Oct., 1959).
It is shown that the continuity of thermodynamic functions in
ydromagnetic shock wave depends upon the presence of thermal
nductivity, viscosity or radiation density. See also following
stract. A.H.Gabriel

361 ON THE PAPER OF V.A. BELOKON'. "THE PERMANENT STRUCTURE OF SHOCK WAVES WITH JOULE
SSIPATION". A.G.Kulikovskii and G.A.Lyubimov.
. eksper. teor. Fiz. (USSR), Vol. 37, No. 4(10), 1173-4 (Oct.,
59). In Russian. English translation in: Soviet Physics—JETP
SA), Vol. 37(10), No. 4, 835-6 (April, 1960).
The Riemann discontinuity in the flow parameters of a com-
ession wave which was postulated by Belokon' (preceding abstract)
criticized. E.R.Wooding

362 ROTATION OF A SPHERE IN A VISCOUS CONDUCTING FLUID IN A MAGNETIC FIELD.
Z.Gershuin and E.M.Zhukhovitskii.
. tekh. Fiz. (USSR), Vol. 30, No. 9, 1067-73 (Sept., 1960). In
ssian.
This paper treats the motion of a viscous incompressible con-
cting fluid containing a solid conducting sphere rotating about an
is parallel to an applied uniform magnetic field. The hydro-
namic and magnetic Reynolds numbers are both assumed small.
e velocity field, induced magnetic field, and decelerating couple
the sphere, are calculated. The couple varies as the square of
e field when the latter is small (small Hartmann number), but is
oportional to the field when it is large. [English translation in:
viet Physics—Technical Physics (USA)]. O.Penrose

363 HEAT-TRANSFER NEAR THE STAGNATION POINT OF A BODY OF REVOLUTION IN THE PRESENCE OF A
AGNETIC FIELD. R.X.Meyer.
angew. Math. Phys. (Switzerland), Vol. 11, No. 2, 127-46 (March
, 1960).
The rate of heat transfer is discussed for an electrically con-
cting, viscous and incompressible fluid flowing towards a flat
ate, in the presence of a magnetic field. Maxwell's and modified
avier—Stokes' equations are solved. The distributions of velo-
ty, magnetic field strength and temperature are determined and
mputed. Heat transfer at the stagnation point is found to decrease
onotonically with the increase in the magnetic field strength.
M.Hasan

ELECTROMAGNETIC WAVES AND OSCILLATIONS

(See also Plasma Oscillations)

RELATED EXPERIMENTS WITH SOUND WAVES AND ELECTRO-
AGNETIC WAVES. See Abstr. 199

THE ANALOGY OF ACOUSTIC AND ELECTROMAGNETIC
UNDARY-VALUE PROBLEMS. See Abstr. 200

364 SCREENING EFFECT OF A CIRCULAR DISK. T.S.E.Thomas.
Amer. J. Phys., Vol. 29, No. 1, 37-9 (Jan., 1961).

A theory of the effect of a circular metal disk in screening the electric field of a pole and the magnetic field of a radio-frequency dipole (eddy current screening) on the axis is developed in terms of spheroidal functions. The screening effectiveness is defined as the ratio of the screened to the unscreened field and curves are given showing its variation along the disk axis. In the electrical case the field is zero at a certain distance along the axis.

365 ON A SINGULAR SOLUTION FOR THE TRIODE RELAXATION OSCILLATOR. L.Sideriades.
J. Phys. Radium (France), Vol. 20, No. 8-9 766-8 (Aug.-Sept., 1960).
In French.

Demonstrates, both theoretically and experimentally, the existence of an unstable limit cycle, inside the stable limit cycle, for the case of a tuned anode oscillator when a resistance which is large, cf.the internal grid-cathode resistance is placed in series with the grid. A.H.W.Beck

366 THREE-LEVEL MASER DETECTOR FOR ULTRAMICROWAVES. K.Shimoda.
J.Phys. Soc. Japan, Vol. 14, No. 7, 966 (July, 1959).

It is proposed to use a three-level system with the smaller energy spacing corresponding to centimetre waves and the larger spacing to sub-millimetre waves. The incidence of sub-millimetre waves would change the population in one level that effects the absorption of centimetre waves. As this latter quantity can be measured accurately it could be used as a detector for the sub-millimetre waves. A sensitivity of 3×10^{-10} W is calculated for a possible case. D.Walsh

367 STUDY OF THE FREQUENCY VARIATION OF A PARALLEL OSCILLATORY CIRCUIT AS A FUNCTION OF THE REACTANCE INSERTED IN SERIES WITH THE MEASURING CONDENSOR CONTAINING A SEMICONDUCTING DIELECTRIC. S.Ivanov.
J. Phys. Radium, Vol. 20, Suppl. No. 7, 60A-65A (July, 1959).
In French.

Experimental measurements were made on the influence of a resistance connected in series with the measuring condenser containing a crystallophosphor on changes of the capacity of the condenser. A theoretical explanation is given of the relation between the changes of the capacity of the oscillatory circuit as a function of the magnitude of the series resistance R of the measuring condenser in this particular case when ΔC is constant, g is exceedingly small and $\Delta g = 0$. Expressed graphically this relation had precisely the same characteristics as the one found experimentally. An analytic and graphical relation of the conductivity Δg_x of the dielectric in the measuring condenser with the magnitude of R were found to agree. Thus the series resistance affects both the capacity and the losses in accordance with the frequency of the oscillatory circuit. The relation of ΔC_x and Δg_x as a function of R in another particular case has been found when $\Delta C = 0$, g is small, but $\Delta g \neq 0$. In this case the relation of Δg_x and R at constant Δg is analogous to the relation between ΔC_x and R and is plotted graphically. The relation of ΔC_x and R when $\Delta C = 0$ gives a minimum for $R = R_0/\sqrt{3}$; for the same value, the change of Δg_x with respect to R at $\Delta g = 0$ gives a maximum value.

368 TIME DELAY AND FREQUENCY RESPONSE OF RESONANT CAVITIES. A.G.Mungall and D.Morris.
Canad. J. Phys., Vol. 38, No. 11, 1510-15 (Nov., 1960).

The frequency response and time delay characteristics of resonant cavities are discussed. It is found that a signal travelling through a resonant cavity undergoes a time delay dependent on both the cavity Q and also the difference between the signal and resonant frequencies. The time delay for a frequency-modulated wave is calculated and checked experimentally.

369 ELECTROMAGNETIC REFLECTION FROM SOUND WAVES. H.J.Schmitt and Tai Tsun Wu.
J. Acoust. Soc. Amer., Vol. 32, No. 12, 1660-7 (Dec., 1960).

The reflection of electromagnetic waves normally incident on the wavefronts of a semi-infinite standing sound wave in a liquid is discussed theoretically. Since the reflecting planes of maximum sound pressure disappear periodically, the reflected electromagnetic signal is modulated with the acoustic frequency. The modulated reflected electromagnetic wave arises (1) from the microscopic movement of the liquid surface, and (2) from the direct analogue of Bragg reflection in optics. The second effect is most pronounced when the wavelength of the electromagnetic radiation in the liquid is twice the acoustic wavelength.

370 FRAUNHOFER DIFFRACTION OF AN ELECTROMAGNETIC WAVE. B.Karczewski.

Bull. Acad. Polon. Sci. Ser. Sci. math. astron. phys. (Poland), Vol. 7, No. 10, 633-8 (1959).

Adapts Kottler's formulation of Huygens' principle for electromagnetic waves (1923) to Fraunhofer diffraction, when both the source and observation points are at infinity. After formulating vector components of the Fraunhofer wave, the author concludes that electromagnetic waves propagated according to the laws of geometrical optics play no part in Fraunhofer diffraction phenomena and that the vector field is determined by the Kirchhoff's terms only.

J.K.Skwirzynski

HIGH-FREQUENCY DIFFRACTION OF PLANE WAVES BY AN INFINITE SLIT. II. See Abstr. 241

371 SCALAR DIFFRACTION BY A PROLATE SPHEROID AT LOW FREQUENCIES. T.B.A.Senior.

Canad. J. Phys., Vol. 38, No. 12, 1632-41 (Dec., 1960).

For the scalar problem of the diffraction of a plane wave by a prolate spheroid the exact solution is known, and by expanding this in ascending powers of ka, where k is the wave number and 2a is the interfocal distance, the Rayleigh series for both the "soft" and "hard" bodies are obtained up to and including terms in $(ka)^6$. The corresponding results for an oblate spheroid can be deduced by a trivial change of parameters. Some particular cases are examined.

372 SCATTERING BY A NARROW UNIDIRECTIONALLY CONDUCTING INFINITE STRIP. S.R.Seshadri.

Canad. J. Phys., Vol. 38, No. 12, 1623-31 (Dec., 1960).

The scattering of a plane electromagnetic wave of wave number k by a strip of width 2a was investigated. The problem is formulated in terms of an integral equation whose solution is obtained by a well-known procedure in the form of a series in powers of ka. Expressions for the far-zone fields and the first two terms in the series for the total scattering cross section are obtained.

373 BACKSCATTERING FROM A CONDUCTING CYLINDER WITH A SURROUNDING SHELL. M.A.Plonus.

Canad. J. Phys., Vol. 38, No. 12, 1665-76 (Dec., 1960).

Far-field backscattering from a perfectly conducting cylinder with a surrounding shell was investigated. The spacing of the shell from the cylinder and thickness of the shell are arbitrary. The material in the shell is also arbitrary and is characterized by the propagation constant h. The incident plane wave is at right angles to the cylinder, and is either horizontally or perpendicularly polarized. When the shell is thin in units of wavelength a much simpler expression for the backscattered field coefficient is obtained. It was possible to express this coefficient in a form which resembles the coefficient from the conducting cylinder alone plus a perturbation term due to the shell. Another simplification resulted when the propagation constant h of the shell is much larger than the free-space propagation constant k. It was desirable to see what scattering properties a cylinder with a surrounding shell exhibits. The cylinder was chosen to be large with respect to wavelength and the shell spaced a resonant distance from the cylinder. The scattering cross section, for this particular combination of parameters was then given by a slowly converging series which proved too lengthy for hand-computation, and was then programmed for and computed by the IBM 704. The scattering cross section versus shell spacing is shown in graphical form.

374 TE SURFACE WAVES GUIDED BY A DIELECTRIC-COVERED METAL PLANE. D.Morris and A.G.Mungall.

Canad. J. Phys., Vol. 38, No. 12, 1553-9 (Dec., 1960).

Investigations of the phase velocities of TE mode surface waves are described. The surface waves were excited over a sand-covere metal plane and the phase velocities of the first three TE modes determined as a function of the sand depth, at a frequency of about 9300 Mc/s. A phase comparison system was used for the measurements. The simultaneous existence of two modes with different velocities, predicted theoretically for certain sand depths, was found experimentally. The variation of relative surface wave power carried above the dielectric layer with thickness of the layer is also discussed.

375 TRANSIT RADIATION IN A PLATE PLACED IN A WAVEGUIDE. K.A.Barsukov.

Zh. tekh. Fiz. (USSR), Vol. 30, No. 11, 1337-56 (Nov., 1960). In Russian.

Considers radiation occuring during the passage of a particle through a dielectric plate placed transversally in a cylindrical waveguide. The general field analysis leads to an expression for the spectral distribution of radiation. Two special cases are considered, of a "thin" and a "thick" plate, as compared with the wavelength of field inside them. In the last case, conditions for the excitation of Cherenkov's radiation are also derived. The case of "locked radiation" is considered, when the plate acts as a resonator. [English translation in: Soviet Physics—Technical Physics (USA)].

J.K.Skwirzynski

376 PROPAGATION OF ELECTROMAGNETIC WAVES ALONG A THIN PLASMA SHEET. J.R.Wait.

Canad. J. Phys., Vol. 38, No. 12, 1586-94 (Dec., 1960).

It is shown that a thin ionized sheet will support a trapped surface wave. The effect of a constant and uniform magnetic field is to modify the phase velocity and polarization of the surface wave. The essential features are illustrated by numerical results for selected values of the electron density, collision frequency, and gyro frequency. The effect of locating the plasma sheet near and parallel to a conducting plane is also considered. In this situation other modes of a waveguide type are possible in addition to the surface wave.

377 ON THE CALCULATION OF THE FARADAY EFFECT RELATIVE TO THE IONOSPHERE.

E.Argence, E.Harnischmacher, H.A.Hess and K.Rawer.

Ann. Geophys. (France), Vol. 16, No. 2, 272-7 (1960). In French.

Some relations concerning the Faraday effect are established in order to study the observations of the radio transmissions made with the artificial satellite 1958 δ2 (Sputnik III) at Breisach (Germany). The effect is also examined for frequencies higher than 100 Mc/s in view of the studies of lunar echoes and their interest for the structure determination of the ionosphere.

378 POLARIZATION CHARACTERISTICS OF THE DOWN-COMING RADIO WAVE. Y.S.N.Murty and S.R.Khastgir.

Proc. Nat. Inst. Sci. India A, Vol. 25, No. 5, 255-61 (Sept. 26, 1959).

Analytical expressions for ρ and ϕ are obtained from the graphical representation of Bailey (1934) as applied to the Appleton-Hartree formulae and these expressions are shown to be identical with the expressions obtained from the wave-theory equations of Saha, Banerjea and Guha (1947, 1951). Expressions for obtaining electron-density and electron collisional frequency from the polarization parameters, ρ and ϕ, are developed and they are shown to be the same as those given by Roy and Verma (1955). It is concluded that the polarization curves of θ and ψ drawn, for different values of collisional frequencies and electron-densities, by using Bailey's graphical method are identical with those drawn by using the expressions given by Saha, Banerjea and Guha.

379 THE VARIATION OF THE RATE OF FADING WITH FREQUENCY. B.N.Singh and O.P.Simha.

J. atmos. terrest Phys. (GB), Vol. 19, No. 2, 141-3 (Oct., 1950).

The night-time fading speed of radio signals in the frequency range 9605-17 783 kc/s after reflection from the F2-region of the ionisphere has been measured. The night-time fading rate is shown to be proportional to the frequency multiplied by the angle of inciden confirming the earlier, conclusions of Appleton.

C.Hazard

CATALOGUE OF DISTURBANCES IN IONOSPHERE, GEOMAGNETIC FIELD, FIELD INTENSITY OF RADIO WAVE, COSMIC RAY, SOLAR PHENOMENA AND OTHER RELATED PHENOMENA. See Abstr. 21343 of 1960.

Radiofrequency Spectroscopy Techniques

380 NUCLEAR MAGNETIC RESONANCE.

D.J.Kroon.

hilips tech. Rev. (Netherlands), Vol. 21, No. 10, 286-99 (1959-60).

A concise exposition is given of the theory of nuclear magnetic esonance and of the specific absorption it causes of electromagetic waves (usually measured at metre wavelengths) by atomic uclei (especially hydrogen nuclei) placed in a magnetic field. The haracteristic differences between the absorption spectra of liquids nd solids are discussed, and two equipments are described for ecording the absorption spectra of liquids and solids. The article nally deals with some examples illustrating the application of uclear magnetic absorption spectra for obtaining information on he structure of molecules and crystals.

381 A NUCLEAR MAGNETIC RESONANCE SPECTROMETER.

V.J.Kowalewski and R.A.Hoffman.

Iuclear Instrum. and Methods (Internat.), Vol. 6, No. 4, 357-60 March, 1960).

A bridge and pre-amplifier system for observation of nuclear nagnetic resonance at various frequencies is described.

382 A NEW METHOD FOR DETECTING NUCLEAR MAGNETIC RESONANCE ABSORPTION.

A.Derzhanski.

C.R. Acad. Bulg. Sci., Vol. 12, No. 6, 505-8 (Nov.-Dec., 1959).

A marginal oscillator is described in which the level, which may be as low as 1 mV, is kept between two close limits by the output of a bistable circuit triggered by the detected oscillator signal. The integrated output of the bistable circuit is sensitive to the resonance absorption. A block diagram only is given.

E.F.W.Seymour

383 Q-MULTIPLICATION FOR INCREASING NUCLEAR MAGNETIC RESONANCE SIGNALS.

R.Chidambaram.

Proc. Indian Acad. Sci. A, Vol. 50, No. 1, 63-7 (July, 1959).

A method of increasing the strength of nuclear magnetic resonance signals by factors up to 100 or even more is suggested. The principle is to increase the quality factor Q of the coil containing the sample by means of positive feedback. Experiments on proton resonance in water, treated with ferric nitrate solution, using a Q-multiplier with the amplitude bridge, are described.

NUCLEAR PHYSICS

384 HIGH-ENERGY PHYSICS.

P.Preiswerk.

xperientia (Switzerland), Vol. 16, No. 6, 222-8 (1960). In German.

Review of current techniques, with emphasis on accelerators nd detectors. Cosmic-ray research is briefly considered. The lementary particles are classified in a table.

385 SUMMARIZED PROCEEDINGS OF A CONFERENCE ON APPLIED SPECTROSCOPY - SEASCALE, JUNE 1960.

.Bovey and F.T.Birks.

rit. J. appl. Phys., Vol. 11, No. 12, 525-34 (Dec., 1960).

The Summer Conference of the Applied Spectroscopy Group of The Institute of Physics was held at the Windscale Club, Seascale ear the United Kingdom Atomic Energy Authority Works, on 16 nd 17 June, 1960. About fifty members of the group assembled at his conference, and the papers presented, together with the ensuing discussion, are summarized. Among the topics discussed vere the Mössbauer effect, the chemical and isotopic analyses of adioactive materials by spectroscopic and radioactivation techiques, the use of spectroscopy in determination of discharge tempeatures and the development of monitoring systems for beryllium etermination.

APPARATUS
PARTICLE DETECTORS

(Counting circuits are included under Electrical Measurements and Circuits)

386 ON "DELAYED" PULSES IN HALOGEN COUNTERS.

T.Rouskov [Ruskov] and B.Betev.

. R. Acad. Bulg. Sci., Vol. 12, No. 5, 399-402 (Sept.-Oct., 1959).

Using the method of delayed coincidences it was found that the ulse in halogen counters is not delayed more than 5×10^{-7} sec, he resolving time of the coincidence circuit, after the passage of he ionizing cosmic particle, but the discharge develops slowly, the ulse rise time depending on the counter voltage. When the latter ncreases from 365 to 450 V, the rise time, defined as the time aken by the pulse to attain its maximum value, decreases from 7 to μsec. It is thought highly improbable that negative ions are the ause of these delays, the probability of the formation of such ions eing 10^{-2}-10^{-3}. The slow development of the discharge is attributed o the relatively long times between collisions of metastable molecules of the basic gas and the molecules of its admixtures, by means of which the development of the avalanche is achieved.

I.C.Demetsopoullos

387 THE EFFECT OF A UNIFORM MAGNETIC FIELD ON THE WORKING OF GEIGER—MÜLLER COUNTERS.

T.Ruskov and I.Zhelazkov.

C. R. Acad. Bulg. Sci., Vol. 12, No. 6, 517-20 (Nov.-Dec., 1959). In Russian.

The effect was studied on specially made halogen and alcohol quenched counters in magnetic fields up to 12 000 Oe. The field affected the discharge, producing an increase of starting voltage and reducing the pulse amplitude; the effect was more pronounced in halogen counters.

J.M.Zarzycki

388 AUTOMATIC CORRECTION OF COUNTING LOSSES IN A GEIGER—MÜLLER COUNTER USED WITH PERIODICALLY VARYING RADIATION.

B.B. Trott.

J. sci. Instrum. (GB), Vol. 38, No. 1, 20-1 (Jan., 1961).

Correction is achieved by reducing the number of uniformly-spaced timing pulses recorded during the reception of a particular number of pulses from the counter. The action and performance of a circuit which restricts to a suitable portion of the radiation cycle the registration of timing pulses are described.

389 SOFT ULTRA-VIOLET PHOTONS IN SELF-QUENCHING GEIGER—MÜLLER COUNTERS.

R.M.Chaudhri and R.Ullah.

Nature (GB), Vol. 188, 131-2 (Oct. 8, 1960).

Results are given which contradict the theory that soft photons do not play an important part in the spread of the discharge in a soft-quenching G.M. The following conclusions are drawn: (1) soft ultraviolet photons energetic enough to liberate photoelectrons from the cathode are produced in the counter due to recombination of argon ions; (2) ultraviolet photons have a much smaller absorption coefficient in alcohol than is usually assumed; (3) the photoelectric efficiency of a self-quenching counter is dependent on its overvoltage.

C.F.Barnaby

390 ON THE MECHANISM OF MULTIPLE DISCHARGES IN SELF-QUENCHING GEIGER COUNTERS.

O.J.Orient.

Nuclear Instrum.and Methods (Internat.), Vol. 6, No. 4, 309-22 (March, 1960).

Multiple pulses occurring in the plateau and breakdown region of pure ethyl alcohol as well as ethyl alcohol-argon gas mixture filled counter tubes have been studied. A single sweep oscilloscope was used to investigate the shape and the time of appearance of multiple discharges. In pure ethyl alcohol filled tubes the plateau slope and the breakdown region were due to multiple pulses of the same order of magnitude as the "ordinary" pulses. These multiple pulses were produced always immediately after the recovery time. The same process has been observed for ethyl alcohol-argon gas mixture filled tubes. Pulses responsible for the breakdown region were much smaller and occurred after the dead time. The two kinds of multiple pulses may be discriminated electronically and counted separately. These experiments too have shown only "high" pulses occurring in the plateau region whereas at the termination of the plateau region, in the breakdown section for ethyl alcohol-argon gas filling the number of "low" multiple pulses was much higher than that of "high" multiple pulses. According to measurements the "high" multiple pulses result from processes occurring on the cathode surface while the "low" multiple pulses are due to processes in the gas volume. It is assumed that the "high" multiple pulses are caused by the decay of organic gas molecules returning to ground state in the vicinity of the cathode and the "low" ones may be attributed to the decay of metastable argon molecules remaining after the dead-time. The values calculated according to this theory for the plateau and breakdown region of the counters used were in good agreement with the experimental results.

391 GEIGER COUNTER BACKGROUNDS.

B.L.Cohen.

J. sci. Instrum. (GB), Vol. 37, No. 12, 475-8 (Dec., 1960).

An extensive study of counting backgrounds in ten essentially identical Geiger counters is reported. Important long-term time variations were found; their rate is generally less than $\frac{1}{2}$% per day, they change direction frequently and their total magnitude averages about 6%. They could not be correlated with counter efficiency, and were not, in general, correlated among the different counters. Consecutive day differences were generally less than 1%, although about 20% of the time there were non-statistical variations in the same direction in all counters, averaging 2.3% in magnitude. No day—night variations were detected within an accuracy of one part in 300. Temperature effects were found to be extremely important. An experience with an area-wide air contamination is discussed.

392 END-WINDOW PROPORTIONAL FLOW COUNTER TUBE.

S.Forsén and J.Rydberg.

Nuclear Instrum. and Methods (Internat.), Vol. 7, No. 2, 204-6 (May, 1960).

A simple and reliable end-window proportional flow counter is described. The influence of anode wire loop position and size, gas mixture and type of radiation source on the operation characteristics is given.

393 PULSE SPREAD IN PROPORTIONAL COUNTERS.

S.Ramakrishna.

Proc. Indian Acad. Sci. A, Vol. 49, No. 1, 25-30 (Jan., 1959).

The influence of the departure from coaxial cylindrical geometry on the pulse-height spread was investigated in three different counter geometries: (a) eccentric wire counter, W wire along the length of cylinder 3mm from the axis, (b) circular counter, and (c) loop counter, all three being filled with tank argon to a pressure of 10 cm Hg. The half width of the pulse height distribution, defined as the interval containing 50% of all the pulses counted, was ~25% in case (a), in fairly good agreement with theoretical calculations, and ~30% in the other two cases. It is concluded that these spreads can be tolerated where detection of particles of appreciably different energy is the main requirement, rather than absolute energy measurements.

I.C.Demetsopoullos

394 THE ACTION OF FAST SPHERICAL IONIZATION CHAMBERS.

R.D.Connor.

Nuclear Instrum. and Methods (Internat.), Vol. 6, No. 4, 301-8 (March, 1960).

Theoretical equations are presented representing the formation of pulses in fast spherical ionization chambers, with special reference to pulse height as a function of the position of the ionizing event in the chamber. The calculations are extended to ionizing tracks of finite length and it is seen that the pulse height is relatively independent of the position of the track. Wall effects and the performance of a hydrogen filled chamber under neutron irradiation are discussed in detail.

395 THE RESPONSE OF PLASTIC SCINTILLATORS TO HIGH-ENERGY PARTICLES.

T.J.Gooding and H.G.Pugh

Nuclear Instrum. and Methods (Internat.), Vol. 7, No. 2, 189-92 (May, 1960).

The response of the plastic scintillator NE 102 is calculated for protons, deuterons, tritons and alpha-particles up to 160 MeV and it is shown how a linear counter may be constructed. The results of the calculation are tested experimentally for protons and deuterons.

396 PERFORMANCE OF LARGE AREA SCINTILLATION COUNTERS.

C.F.Barnaby and J.C.Barton.

Proc. Phys. Soc. (GB), Vol. 76, Pt 5, 745-53 (Nov., 1960).

The light collection in large plastic and liquid scintillation counters was analysed and it was shown that it was more efficient for the photomultiplier to be in optical contact with one side of the phosphor than to be viewed from above. Experimental results obtained with a large plastic scintillation counter supported this conclusion, as did a survey of other published results. The uniformity of response was about equally good for the two types of counter.

397 A GAS ČERENKOV DETECTOR FOR THE ACCURATE DETERMINATION OF ELECTRON BEAM ENERGY.

R.E.Jennings and P.I.P.Kalmus.

Nuclear Instrum. and Methods (Internat.), Vol. 6, No. 6, 209-12 (Jan., 1960).

Details are given of a variable pressure gas Cherenkov detector which is being used to measure the energy of the electron beam from the U.C.L. 4.5 MeV microtron. Nitrogen which has a Cherenkov threshold at a pressure of about 18 atmospheres for 4.5 MeV electrons is used, but many other gases would also be suitable. The detector is capable of giving an absolute value of the electron energy to an accuracy of about ±0.25%.

398 4π COUNTER WITH DOUBLE ANTICOINCIDENCE CIRCUIT.

F.Alba A., T.A.Bródy and I.Castro V.

Rev. Mexicana Fis., Vol. 8, No. 2, 117-32 (1959). In Spanish.

A new type of connection of the two halves of a 4π gas-flow Geiger counter is presented, in which only pulses occurring in one half are counted, coincidences between the two halves being eliminated as due to cosmic-ray background. This way each half serves as coincidence-protection counter for the other, while contributing to the sample count. Backgrounds are down to about 25 p.p.m. in a 4 in. lead shield, while counting efficiency remains practically equal to 100%. Micromicrocurie activities can be counted, using only very little equipment.

399 RIGID VINYL FILM DOSIMETER.

C.Artandi and A.A.Stonehill.

Nuclear Instrum. and Methods (Internat.), Vol. 6, No. 3, 279-82 (Feb., 1960).

Non-plasticized poly vinyl chloride film has been found to be an inexpensive, simple, reliable dosimeter in the megarad range. Methods for its use in dose measurement, measurement of electron energy (MeV), assurance of adequate ionization penetration and measurements of source geometry, are described.

400 MEGAROENTGEN DOSIMETRY EMPLOYING PHOTOGRAPHIC FILM WITHOUT PROCESSING.

W.L.McLaughlin.

Radiation Research (USA), Vol. 13, No. 4, 594-609 (Oct., 1960).

This method of high-level dosimetry of X- and γ-radiation involves two steps: (1) Large radiation exposures are given, resulting in the formation of print-out image in the silver halide emulsion layers of ordinary commercial X-ray films, without requiring photographic processing for the evaluation. (2) The unknown exposure is measured by means of a special densitometric procedure, the exposure being related to the net density of the print-out darkening on a characteristic curve obtained with known exposures. The density readings are made with a narrow band of red light, obtained by placing a suitable band-pass filter between the densitometer light source and the film. Gamma-radiation exposures from 2×10^4 to 10^8 r can be read with a precision limit of ±5%, under appropriate conditions of densitometry. The response is rate-independent, and the print-ou image is stable. The chief limitations in the method are a considera dependence of response on radiation energy below 0.3 MeV and the requirement of controlling the temperature during exposure to withi ±10° C for accurate readings.

401 PULSE ANALYSIS IN THE STATISTICAL REGION.
F.Sicard.
ıclear Instrum. and Methods (Internat.), Vol. 7, No. 2, 207-9
lay, 1960). In French.

This paper deals with experiments done with pulses having a atistical time distribution. A commutation over several channels studied. The counting loss and the efficiency of each channel are lculated in the case of a Poisson distribution.

MEASUREMENT OF THE COEFFICIENT OF CHARGE OLLECTION IN p—n JUNCTION PARTICLE DETECTORS: NEW ETHOD OF MEASURING LIFE TIMES. See Abstr. 20886 of 1960.

rack Visualization

402 INVESTIGATIONS ON THE IDENTIFICATION OF UN-STOPPED PARTICLES IN NUCLEAR EMULSIONS.
ESTIMATION OF IONIZATION RANGE FROM AVERAGES OF HARACTERISTIC QUANTITIES ON TWO SECTIONS OF THE TRACK.
.Alper, J.Auslånder, C.Bercea and E.Friedlånder.
tud. Cercetari Fiz. (Roumania), Vol. 9, No. 2, 185-90 (1958).
ı Roumanian.

Scattering measurements and gap counting have been carried ut on 20 p, π and μ tracks, at given distances from the end of the onization range. The results show that only in favourable cases ong tracks) is it possible to establish in a statistically significant ıanner that the residual ionization range is different from zero.

403 INVESTIGATIONS ON THE IDENTIFICATION OF UN-STOPPED PARTICLES IN NUCLEAR EMULSIONS.
I. ON RESIDUAL IONIZATION RANGE ESTIMATION FROM GAP IEASUREMENTS IN NUCLEAR EMULSIONS. E.Friedlånder.
tud. Cercetari Fiz. (Roumania), Vol. 9, No. 2, 191-4 (1958).
ı Roumanian.

By applying a procedure of maximum likelihood, it is shown ıat the residual ionization range can be estimated from gap measrements. Results obtained on 15 p, π and μ tracks confirm the orrectness of the applied procedure.

404 INVESTIGATIONS ON THE IDENTIFICATION OF UN-STOPPED PARTICLES IN NUCLEAR EMULSIONS.
I. ON MASS ESTIMATION OF NON-STOPPED IONIZING ARTICLES IN NUCLEAR EMULSIONS. S.Alper.
tud. Cercetari Fiz. (Roumania), Vol. 9, No. 2, 191-4 (1958).
ı Roumanian.

It is shown that by applying conventional constant sagitta chemes to tracks of un-stopped particles it is possible, by an ppropriate statistical treatment, to obtain an improved mass stimation. Measurements on 8 π and μ tracks confirm the orrectness of the applied procedure.

405 ON THE SIZE DISTRIBUTION OF STARS OBSERVED IN NUCLEAR EMULSIONS. G.Bozóki and É.Gombosi.
cta phys. Hungar., Vol. 11, No. 4, 307-16 (1960).

According to measurements reported by several authors, the equency distribution of stars produced in nuclear emulsions by osmic radiation represented in terms of the number of their gray nd black prongs yields a curve consisting of two straight lines which itersect at a prong number N about 7.5. Upon analysing the results measurements on cosmic radiation and comparing them with those btained in high-energy accelerator experiments, it is found that the bove basic feature of the frequency curve is mainly the consequence the energy spectrum of the primary particles generating these ars.

406 BUBBLE COUNTING ON LOW ENERGY PARTICLE TRACKS. I.R.Birss.
lature (GB), Vol. 184, 1474 (Nov. 7, 1959).

The author gives evidence that it is possible to separate pion racks from proton tracks in a bubble chamber by plotting bubble ensity against range, but the type of chamber is not mentioned. lots of bubble density against $1/\beta^2$ ($\beta = v/c$) gave straight lines. he dependence of the slope of the line on particle mass is not exlained by current theories. T.O.Jeffries

407 RELATIVISTIC INCREASE IN BUBBLE DENSITY IN A $CBrF_3$ BUBBLE CHAMBER. B.Hahn and E.Hugentobler.
Nuovo Cimento (Italy), Vol. 17, No. 6, 983-5 (Sept. 16, 1960).

Describes bubble density determinations for tracks obtained in a $CBrF_3$ bubble chamber. Bubble densities were determined along pion tracks of known momenta (10, 16 and 17 GeV/c) and for the decay products of 14 K^0 decays and 4 Λ^0 decays. The results show a definite increase (30 ± 5%) at $\gamma = 100$ over the minimum bubble density. The bubble density curves are compared to a theoretical curve of the form

$$\rho = \frac{0.056}{\beta^2}[\log(\gamma^2 - 1) + 15 - \beta^2].$$

R.H.Thomas

408 THE PROPANE BUBBLE CHAMBER USED WITH THE BIRMINGHAM PROTON SYNCHROTRON.
J.D.Dowell, W.R.Frisken, G.Martelli and B.Musgrave.
Nuclear Instrum. and Methods (Internat.), Vol. 7, No. 2, 184-8 (May, 1960).

The design of a piston operated propane bubble chamber which has been used in conjunction with the 1 GeV proton beam of the Birmingham synchrotron is described. The operating conditions and the method of analysis of photographs are discussed.

409 BUBBLE DENSITY MEASUREMENT IN A DIETHYL ETHER BUBBLE CHAMBER. G.Kesseler and C.Schlier.
Nuclear Instrum. and Methods (Internat.), Vol. 7, No. 2, 210-12 (May, 1960). In German.

The bubble density of minimum ionizing electron tracks was measured in a diethylether bubble chamber over a wide range of temperature and pressure in the liquid. Some results can be compared with theory.

410 INFLATABLE GASKET FOR THE 72 INCH BUBBLE CHAMBER. L.R.Lucas and H.P.Hernandez.
Rev. sci. Instrum (USA), Vol. 30, No. 10, 941-2 (Oct., 1959).

An ingenious pressure seal for the Berkeley 72 in. liquid hydrogen bubble chamber is described in which indium wire is held in contact with the glass window by an inflatable stainless steel bellows. Details of construction and performance are given.

T.O.Jeffries

411 ON AN INDEX OF IDENTIFICATION OF 100 MICRON TRACKS IN NUCLEAR PHOTOGRAPHIC EMULSIONS.
F.Senent, E.Villar, R.Font, L.Miralles, A.García and J.Catalá.
An. Real Soc. Espan. Fis. Quim. (Spain), Vol. 55(A), No. 9-10, 251-62 (Sept.-Oct., 1959). In Spanish.

A mean line is constructed from the irregular particle track, by dividing the latter into cells of suitable size, and its radius of curvature used to define an index of identification which is independent of the emulsion processing. The influence of the cell size on the accuracy of the method is discussed and formulae for the elimination of background noise are derived. The results show that a statistically good discrimination of proton, deuteron, and α-particle short tracks is obtained. I.C.Demetsopoullos

412 RECOVERY OF THE THICKNESS OF NUCLEAR PHOTOGRAPHIC EMULSIONS BY TREATMENT WITH COLOPHONY RESIN. J.Catalá and J.Casanova.
An. Real Soc. Espan. Fis. Quim. (Spain), Vol. 55(A), No. 9-10, 263-6 (Sept.-Oct., 1959). In Spanish.

Alcoholic solutions of colophony resin were used for the swelling of nuclear photographic emulsions after processing. The factors affecting the recovery of the emulsion thickness are discussed, and graphs are given showing the degree of recovery and the final thickness as function of the time and concentration of the solution. The refractive index of the solution is also given as function of the concentration. For the solution used the refractive index was 1.5192 ± 0.0096, practically equal to that of the emulsion.

I.C.Demetsopoullos

413 ELECTRON BACKGROUND IN NUCLEAR EMULSIONS. V.D.Hopper and J.E.Laby.
Austral. J. Phys., Vol. 13, No. 2, 202-4 (June, 1960).

An analysis of 60 batches of nuclear emulsion arriving in Australia by sea from England, and about 100 batches arriving by air, in the period January 1955 to June 1959, shows that emulsion transported by air is more prone to excess radiation damage.

E.J.Burge

414 COMPARATIVE STUDY OF THE SENSITIVITY OF NUCLEAR EMULSIONS IN THE RANGE +20 TO −196° C TO LIGHT RADIATION AND TO α-PARTICLES FROM POLONIUM.

M.Debeauvais-Wack.
C.R. Acad. Sci. (France), Vol. 251, No. 1, 76-8 (July 4, 1960).
In French.

The variation in the sensitivity of Ilford G5 and C2 emulsions exposed to light and to α-particles over the temperature range of +20 to −190° C was studied photometrically. The results can be interpreted according to the model of surface migration of sensitized centres, and which as such would permit a differentiation between particles of different energies to be made. S.J.St-Lorant

415 STUDY OF THE LOADING OF CERTAIN NUCLEAR EMULSIONS WITH BORON AND LITHIUM.

V.Labău and M.Nicolae.
Stud. Cercetari Fiz. (Roumania), Vol. 9, No. 2, 231-40 (1958).
In Roumanian.

In order to determine neutron fluxes, methods of loading NIFKI K 100 μ emulsion with boron and lithium were considered. The procedure is described and under the experimental conditions the absorption curve of B and Li in 1 cm^3 of emulsion obtained. The variation of the characteristic working properties of the emulsion as a function of the concentration of the loading elements was investigated. Using the procedure given, emulsions containing 10 to 120 mg of B per cm^3 of emulsion and 3.5 to 20 mg of Li per cm^3 of emulsion were prepared. S.J.St-Laurant

416 ON THE SIMULTANEOUS DISTRIBUTION OF THE SAGITTAS OF A TRACK IN EMULSION IN THE CASE OF BACKGROUND NOISE. L.Jánossy.

Acta phys. Hungar., Vol. 12, No. 2, 139-50 (1960).

A simple method is given for evaluating the simultaneous distribution function of sagittas of a track in an emulsion in the case of Coulomb scattering only and also when background noise is present.

NUCLEAR FIELD THEORY

417 APPROXIMATE TREATMENTS OF WEAK AND STRONG COUPLING FOR CHARGED SCALAR THEORY USING THE CHEW—LOW FORMALISM. H.Jahn.

Fortschr. Phys. (Germany), Vol. 7, No. 8, 451-80 (1959). In German.

In the first part, the author reviews the derivation of the Low equation and discusses conventional techniques for obtaining approximate solutions, including the treatment of Goebel (Abstr. 2142 of 1958) for the strong coupling limit. The second part considers the application of the field-decomposition method of the author to the strong coupling limit. Extension to the case of pseudoscalar particles does not appear to present any difficulties. E.J.Squires

418 GEOMETRIC THEORY OF CHARGE.

H.Ekstein.
Phys. Rev. (USA), Vol. 120, No. 5, 1917-25 (Dec. 1, 1960).

The symmetry properties of elementary particles—in particular the number of linearly independent states with a fixed mass and momentum—can be explained by relativistic covariance alone, if the irreducible representation assigned to particles with antiparticles is chosen so that if contains $2(2s + 1)$ linearly independent states for fixed mass and momentum. No nongeometric symmetry element such as charge conjugation is introduced. The existence of superselection rules within these irreducible representations is made necessary by the postulate that time-reversal invariance be directly verifiable. In this representation, the space-inversion operator has the same effect as the product PC in the usual representation. A charge operator Q is defined and it is shown that all physically realizable states are eigenstates of Q with integral eigenvalues. For "simple" particles, Q can have only the eigenvalues 0, ± 1.

419 ON THE INTERPRETATION OF ISOVECTOR COMPONENTS. J.Lukierski.

Bull. Acad. Polon. Sci. Ser. Sci. math. astron. phys. (Poland), Vol. 7, No. 9, 577-81 (1959).

This is a discussion of some aspects of the Pauli—Güersey group, which, in addition to the Lorentz group, is associated with a massless Dirac equation. A classical Dirac field only is considered. J.C.Taylor

420 SOME REMARKS ON GENERAL RELATIVITY AND THE DIVERGENCE PROBLEM OF QUANTUM FIELD THEORY

O.Klein.
Nuovo Cimento Suppl. (Italy), Vol. 6, No. 1, 344-8 (1957).

A combination of micro- and macro-constants gives rise to a small length L_0 of subnuclear dimensions. It is suggested that L_0 provides a lower limit to the linear dimensions of a region within which a particle could be confined. R.A.Newing

421 RENORMALIZATION CONSTANTS IN QUANTUM ELECTRODYNAMICS. P.C.DeCelles.

Phys. Rev. (USA), Vol. 121, No. 1, 304-11 (Jan. 1, 1961).

The electron self-energy and wave-function renormalization constant are calculated with the use of the technique of dispersion relations. In order to do this, exact representations of these renormalization constants are obtained in terms of matrix elements of Heisenberg field operators. The matrix element $\langle e\gamma | \bar{\psi} | 0 \rangle$ is studied in detail and its contribution to the renormalization constants determined. In retaining only the contributions due to $\langle e | \bar{\psi} | 0 \rangle$ and $\langle e\gamma | \bar{\psi} | 0 \rangle$ an infinity of other matrix elements is ignored. A test of the validity of this approximation is discussed. Within the limits of the approximations, the self-energy and wave-function renormalization constants are shown to have a logarithmic, ultraviolet divergence. The wave-function renormalization constant also has an infrared divergence.

422 HIGH ENERGY BEHAVIOR OF CROSS SECTIONS IN QUANTUM ELECTRODYNAMICS.

K.E.Eriksson and A.Peterman.
Phys. Rev. Letters (USA), Vol. 5, No. 9, 444-5 (Nov. 1, 1960).

When considering radiative corrections, it is known that terms of the type $(\alpha/\pi)^n ln^{2n}(q^2/m^2)$, where q is the invariant momentum transfer and m the electron mass, are likely to occur in a series expansion in α, i.e., an expansion in $(\alpha/\pi) ln^2(q^2/m^2)$. If one consider an experiment in which $q^2 = 10^6 m^2$ then the convergence of the perturbation becomes doubtful. The authors claim that detailed investigation shows that this expansion should be in terms of an effective parameter which is at most $(\alpha/\pi) ln^{4/3}(q^2/m^2)$. J.H.Gunn

423 TESTING QUANTUM ELECTRODYNAMICS BY MEANS OF COMPTON SCATTERING AND PAIR ANNIHILATION

H.Salecker.
Z. Phys. (Germany), Vol. 160, No. 4, 385-405 (1960). In German.

Compton scattering and pair annihilation in flight are analysed as purely electrodynamic processes to test quantum electrodynamics at small distances. After a short discussion of the introduction of the form factors, the possibility is considered of a (partial) cancellation between electrodynamic and nucleon structure effects. There is also the possibility of a partial cancellation of the non-local effect in Compton scattering and wide angle bremsstrahlung because of the opposite action of space-like and time-like form factor arguments. The Compton and the two-photon pair-annihilation cross-sections are calculated with form factors and the result is illustrated by several numerical diagrams. Two-photon pair-annihilation turns out to be especially favourable for a first test of quantum electrodynamic because there is no cancellation of possible non-local effects and the necessary very high energy can be circumvented by a colliding beam experiment. With a 10% experimental error, the projected colliding beam experiment at Stanford at 500 MeV could test the electron propagation function down to 0.6×10^{-14} cm. Compton scattering can then be used to investigate the electron propagation function also for time-like arguments.

424 ON THE GENERALIZED QUANTUM ELECTRODYNAMICS. S.Sasaki.

Kumamoto J. Sci. A (Japan), Vol. 4, No. 3, 176-91 (Feb., 1960).

The equations of quantum electrodynamics are generalized so as to be invariant under proper, but not improper, Lorentz transformations. The theory does not exhibit violation of parity or charge conjugation invariance for the free field or for the field interacting through the usual vector interaction, but only when a Pauli-type interaction is assumed. The two-component neutrino theory is obtained as a special case of the generalized equations. Yukawa interactions in general fall into two classes: those which do not violate parity and charge conjugation invariance, and those which do. E.J.Squires

425 CHARACTERS OF THE ELECTROMAGNETIC AND STRONG MESONIC INTERACTIONS. S.Sasaki.

ımamoto J. Sci. A (Japan), Vol. 4, No. 4, 300-20 (Aug., 1960).

A detailed treatment of previous work (Abstr. 17227 of 1960), ıich is extended to include vector coupling.

426 TRANSFORMATION OF THE ELECTROMAGNETIC NULL FIELD UNDER THE NEW LORENTZ SUBGROUP, ND THE MOMENTUM ENERGY OF PHOTON RADIATED FROM OVING PARTICLE. T.Shibata.

em. Fac. Engng Hiroshima Univ. (Japan), Vol. 1, No. 2, 93-101 ec., 1958).

In non-relativistic kinematics the Galilean transformations thout rotation of the Cartesian axes form a 3-parameter group, garding the three components of the velocity of Galilean observer the other as parameters. This is, however, not the case in relaristic kinematics, for if two Lorentz transformations are combined thout rotation the resultant Lorentz transformation will in general rrespond to a change of orientation of the Cartesian axes. Namely, e ∞^3 Lorentz transformations without rotation do not form a 3-paraeter group. This fact is undesirable. So, the Lorentz transformaons without rotation are modified in such a way that they form a parameter subgroup G_3 of the general Lorentz group, regarding e three components of the relative velocity of one observer to the ner as parameters. The Doppler effect for light is deduced rectly by considering the transformation of the subgroup G_3. rther, the fact that the momentum energy four-vector for a photon diated from a moving particle depends on the velocity of the parcle can be inferred. The exact expression for this momentum vector is obtained by means of the subgroup G_3.

427 DIVERGENCE OF THE GREEN'S FUNCTION SERIES FOR REARRANGEMENT COLLISIONS.

.Aaron, R.D.Amado and B.W.Lee.

hys. Rev. (USA), Vol. 121, No. 1, 319-23 (Jan. 1, 1961).

The convergence of the Born series for rearrangement collisions investigated in a potential model. For a certain class of potenals it is shown that the iterated series for the full two-particle reen's function, $(\vec{k}_1{}'\vec{k}_2{}'|G(E)|\vec{k}_1\vec{k}_2)$, in terms of either the freearticle Green's function, the initial state Green's function, or the nal state Green's function, diverges for some continuous range of e variables $\vec{k}_1$, $\vec{k}_2$, $\vec{k}_1{}'$, and $\vec{k}_2{}'$ independent of the energy, E, of the cident particle. It is suggested that the usual Born series, which an integral over this Green's function series, therefore, also verges for rearrangement collisions independent of the incident ergy.

428 AN INVESTIGATION OF THE NEW TAMM–DANCOFF METHOD. H.J.Kaiser.

nn. Phys. (Germany), Vol. 6, No. 3-4, 131-49 (1960). In German.

The new Tamm–Dancoff method, which considers matrix ements between real rather than bare states, is illustrated first considering a quantum mechanical problem for both weak and rong coupling. It is shown that energy differences between adcent states can be obtained more accurately than the energies emselves. The method is generalized to apply to field theoretic oblems, and, in particular, is applied to a non-linear boson field eory and to the non-linear theory of Heisenberg. In the latter case, infinite discrete mass spectrum, m_n proportional to

$$\sum_1^n [3/(2n'^2 + 1)]^{1/4}$$

obtained. E.J.Squires

429 MESON–FERMION PV-INTERACTION IN THE THIRRING MODEL. II. G.Póscik.

cta Phys. Hungar., Vol. 12, No. 1, 55-65 (1960).

For Pt I, see Abstr. 7290 of 1960. The Thirring model cometed by a meson–fermion PV-coupling is discussed from the oint of view of renormalization. It is shown that in the perturative approach the S-matrix contains unrenormalizable diverences coming from the PV-part. For the renormalization of the V-part the (neutrino-like) n-fermion m-meson Green's functions the PS(PV)-theory are examined in a non-perturbative manner. he propagators can be made finite by Z_2 renormalization. After aving calculated the exact Green's functions, it is easily seen that, st as in the S(V)-theory, there are no physical effects. The resent results, which are exact in one dimension, have only approimate validity in the real four-dimensional case. The approximaon means omission of all the closed vacuum loops.

430 REMARKS ON COMPOUND MODELS, CONSERVED CURRENTS AND WEAK INTERACTIONS. M.E.Mayer.

Nuovo Cimento (Italy), Vol. 17, No. 5, 802-3 (Sept. 1, 1960).

431 EFFECT OF WEAK INTERACTIONS ON THE ELECTRON PROPERTIES OF FERMIONS. A.M.Brodskii.

Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 2(8), 322-5 (Aug., 1960). In Russian.

Proper mass effects and the peculiarities of the behaviour of fermions in a magnetic field caused by the universal Fermi interaction are considered in the first order in the constant G_F. It is shown that violation of parity in weak interactions does not induce any violation of parity in the field mass. An expression describing the effect of weak interactions on the electromagnetic properties of the fermions is found. The expression is proportional to the external current and is about 10^{-2} times smaller than the similar expression which is obtained by taking into account the vacuum terms in electrodynamics. [English translation in: Soviet Physics—JETP (USA)].

432 $|\Delta S| = 1$, $|\Delta I| = \frac{1}{2}$ RULES WITH TWO CHARGED INTERMEDIATE BOSON FIELDS. B.d'Espagnat.

Nuovo Cimento(Italy), Vol. 18, No. 2, 287-303 (Oct. 16, 1960).

The rules $|\Delta S| = 1$ for non leptonic decays and $|\Delta I| = \frac{1}{2}$ are accounted for by a theory in which weak interactions are due to charged intermediate bosons that have no neutral counterpart. Leptonic decays of strange particles where the total charge of the leptons is zero are thereby forbidden, in accordance with experiment. Observable differences with the prediction of the Lee and Yang theory are discussed. The theory gives arguments in favour of the existence of a decay mode of the cascade particle into a nucleon and leptons with a coupling constant equal to that of the leptonic decay mode of the Λ, i.e. with a decay rate about twenty times smaller than the rate for the normal Ξ-decay.

433 ON SOME COMPOUND MODELS FOR THE STRONG INTERACTIONS. M.Tonin.

Nuovo Cimento (Italy), Vol. 18, No. 2, 304-15 (Oct. 16, 1960).

The possibility that the strongly interacting particles are compound structures of fundamental Majorana fields is investigated from the point of view of their symmetry properties, assuming that the strong interactions possess larger symmetries than the one leading to the baryon number, isotopic spin and strangeness conservation. The problem of the parity conservation in the theories investigated is also discussed.

434 EXPERIMENTAL TESTS OF CERTAIN HYPOTHESES OF SYMMETRY RELATIVE TO STRONG INTERACTIONS. B.D'Espagnat, A.Martin and J.Prentki.

Nuclear Phys. (Internat.), Vol. 20, No. 4, 543-56 (Nov. (3), 1960). In French.

Various tests for the global symmetry and for the Salam–Polkinghorne assumption are proposed. In the high energy reactions considered, such as antibaryon production, it is expected that the global symmetry might be more apparent than in reactions involving K mesons at low energies. While the tests for the universality of the pion–hyperon coupling are described by equalities, those which apply to a comparison between the pion–hyperon and pion–nucleon couplings are expressed in terms of inequalities between cross-sections for different processes. This is a consequence of indiscernibility and of the presence of the target nucleon in the initial state. These inequalities might, however, prove to give rather simple tests as they hold independently of the number of emitted pions. The tests for the Salam–Polkinghorne assumption are chosen so as to give a lower limit on the number of Ξ's appearing in a reaction, while the previously proposed tests gave an upper limit. Finally phase space effects are briefly discussed.

435 WEAK-COUPLING CURRENTS AND SYMMETRIES OF STRONG INTERACTIONS. R.E.Behrends and A.Sirlin.

Phys. Rev. (USA), Vol. 121, No. 1, 324-36 (Jan. 1, 1961).

The general isotopic properties of bilinear currents which will lead to the $|\Delta S| \leq 1$ and $|\Delta I| = \frac{1}{2}$ rules for weak decay processes are examined. The latter rule is re-expressed in terms of an equivalent mathematical statement which permits one to obtain the usual predictions in a simple manner. In general, when the strangeness-conserving part of such a current is an isotopic vector, the strangeness-changing part can be a linear combination of $I = \frac{1}{2}$ and $I = \frac{3}{2}$ currents. The existence of an $I = \frac{3}{2}$ current could be established by experiments on the decays $K \rightarrow \pi$ + leptons, or on high-energy neutrino capture, $\nu + N \rightarrow \mu + \Sigma$. Experiments on K_{e4} decays could test the bilinearity of the current. The assumption that the vector part of such a current, both strangeness changing and nonchanging, is quasi-conserved (i.e., neglecting certain mass differences) in the presence of the strong interactions fixes the specific form of the current and further implies symmetries for the strong couplings. The various transformations which leave invariant a Yukawa-type strong interaction as well as their associated currents are found. A new possible symmetry group of the strong interactions is examined: a 14 parameter group usually denoted as G2. In the presence of both π and K couplings, it is found that $I = \frac{1}{2}$ and $\frac{3}{2}$ currents are quasi-conserved when the strong Lagrangian has a 7-dimensional rotational symmetry, while for the $I = \frac{3}{2}$ alone, the symmetry required is G2. In the presence of only π-baryon couplings, only $I = \frac{1}{2}$ currents can be quasi-conserved. Certain predictions for the K_{e3} and K_{e4} modes of decay and for $\Sigma^- \rightarrow n + e^- + \nu$ follow from the weak currents determined in this way.

436 THE RUIJGROK--VAN HOVE MODEL EXPRESSED IN TERMS OF "DRESSED" OPERATORS.

J.Łopuszański.

Bull. Acad. Polon. Sci. Ser. Sci. math. astron. phys. (Poland), Vol. 7, No. 7, 441-7 (1959).

Using Van Hove's asymptotic stationary states representation (Abstr. 2689, 4847 of 1956), a "dressing" transformation is obtained yielding mass renormalization as well as normalization of the dressed operators and renormalization of the coupling constants.
W.A.Hepner

437 ERRATUM TO THE ARTICLE "THE RUIJGROK—VAN HOVE MODEL OF FIELD THEORY IN TERMS OF "DRESSED" OPERATORS".

J.Łopuszański.

Physica (Netherlands), Vol. 25, No. 12, 1368 (Dec., 1959).

See Abstr. 15238 of 1960. The derivation of one of the equations is incorrect. The correct Hamiltonian for the case of states with only one nucleon is given. However, this equation remains valid as far as the Tamm—Dancoff approximation is concerned.

438 SOME REMARKS ON THE FEYNMAN'S VARIATIONAL METHOD.

M.Namiki.

Progr. theor. Phys. (Japan), Vol. 22, No. 5, 740-2 (Nov., 1959).

Modifications of the Feynman variational method (Abstr. 3261 of 1955) are proposed and a possible application to the calculation of the one-particle Green's function in the meson—nucleon system with ps-coupling is outlined.
K.G.Major

439 PION PARAMETERS FROM HIGH-ENERGY INELASTIC INTERACTIONS.

S.D.Drell.

Phys. Rev. Letters (USA), Vol. 5, No. 7, 342-4 (Oct. 1, 1960).

Contributions of the one-pion exchange term to various inelastic processes are considered. Measurements of the nucleon—nucleon inelastic differential cross-section, as a function of scattering angle in the forward direction, would provide a test of the importance of this term. It is suggested that observation of two pions or two K-particles emerging in coincidence from a $\pi + N$ collision could yield information on the $\pi - \pi$ scattering length or the $\pi\pi$KK interaction respectively.
E.J.Squires

440 DYNAMICS OF PARTICLES WITH INTERNAL "SPIN".

H.Rund.

Ann. Phys. (Germany), Vol. 7, No. 1-2, 17-27 (1960).

A generalized relativistic Lagrangian is suggested, which is such that the momentum vector possesses a component normal to the direction of the velocity, while the convervation of total angular momentum requires the existence of a non-vanishing internal angular momentum tensor (spin). The resulting mechanical system is very similar to the spin models of elementary particles discussed by Hönl, Papapetrou, Bopp and others, as these emerge as special cases. Although the latter are usually derived from variational principles for which the Lagrangian depends on the acceleration, the present theory is based on a Lagrangian depending solely on position and velocity. This method avoids certain mathematical difficulties, and permits the immediate application of the Hamiltonian theory associated with such simple variational principles. Although no radiation effects are considered, the Abraham vector plays an important role in this purely mechanical theory.

441 SCHWINGER'S EQUATION FOR ONE-BODY PROPAGATOR OF A SELFCOUPLED SPINOR FIELD.

G.Pócsik.

Acta phys. Hungar., Vol. 12, No. 2, 181-3 (1960).

This equation is derived, with a view to applying it to the Thirring model.
J.C.Taylor

442 GEOMETRICAL INTERPRETATION OF CONSERVATION LAWS IN THE SPINOR SPACE.

J.Rzewuski.

Bull. Acad. Polon. Sci. Ser. Sci. math. astron. phys. (Poland), Vol. 7, No. 9, 571-6 (1959).

A geometrical interpretation of the conservation laws of angular momentum, isotopic spin, baryon number, charge and hypercharge is given in the framework of the spinor space. Some rules restricti the possible representations to those which correspond to observed particles are discussed. It is shown that, with certain natural assumptions, the spinor space is the only one which may be used for geometrical interpretation of the whole set of known conservation laws.

443 STRUCTURE OF LEPTONS AND MESONS.

G.Rosen.

Nuovo Cimento (Italy), Vol. 18, No. 2, 403-8 (Oct. 16, 1960).

The lepton numbers, strangeness numbers, spins, masses and charges of the lepton-meson group are predicted. Masses agree with experiment to $\frac{1}{2}$%. No undiscovered particles, other than a zero mass, positively charged muon, are predicted.
J.S.Dowker

444 EFFECTIVE RANGE THEORY.

T.Tietz.

Ann. Phys. (Germany), Vol. 6, No. 3-4, 150-2 (1960). In German.

An expression is obtained for the s-wave phase shift for scattering by a Yukawa potential. From this expression, the low-energy cross-section can be obtained in a simple manner.
E.J.Squires

445 THE FIELD THEORETIC DEFINITION OF THE NUCLEAR POTENTIAL. III.

J.M.Charap and M.J.Tausner.

Nuovo Cimento (Italy), Vol. 18, No. 2, 316-41 (Oct. 16, 1960).

For Pt II see Abstr. 12858 of 1960. The scattering of nucleons a energies below the meson production threshold is discussed; the amplitude is a sum of five terms, each proportional to a different spin invariant. A comparison in perturbation theory, between the field-theoretic amplitude and that from potential theory enables one to conclude that a potential which will reproduce the field-theoretic amplitude through the two-meson exchange contributions exists. Thi potential is also a sum of five terms and is "local" in the sense that for a suitable choice of the spin-dependent operators, their coefficients are energy-independent. The potential is derived, apart from radiative and rescattering corrections; it is again observed that the static limit ($\mu/M \rightarrow 0$) is not well defined. The spectral functions for the potential are calculated. Rescattering corrections, etc., are discussed and, assuming simple analyticity properties for Feynman graphs, are shown not to detroy the locality of the potential. It is not yet possible to furnish a proof independent of perturbation theor that a potential exists, as was done for spinless particles in Pt I, because the necessary dispersion relations have not been proved; in fact it is not even known for which choice of spin invariants they might be excepted to hold. Some clues as to this choice of "proper" spin invariants are afforded by the limitations imposed in order tha the fourth-order potential be energy-independent.

446 PROPERTIES OF THE MOMENTUM SPACE ANALYTIC FUNCTION.

H.Araki and N.Burgoyne.

Nuovo Cimento (Italy), Vol. 18, No. 2, 342-6 (Oct. 16, 1960).

Using only the fundamental assumptions of Lorentz covariance, locality, and mass spectrum certain results are derived concerning the analytic function in momentum space. The boundary values of this function are closely related to the scattering amplitudes.

447 THE TWO-BODY PROBLEM IN THE EXTREME RELATIVISTIC LIMIT.

K.Baumann and W.Thirring.

Nuovo Cimento (Italy), Vol. 18, No. 2, 357-67 (Oct. 16, 1960).

In view of the composite model for elementary particles the two-body problem is studied in the extreme relativistic limit. Spinless particle—antiparticle bound states are investigated for a single massless self-interacting Weyl field. High momenta are suppressed in a Lorentz invariant manner by introducing a heavy auxiliary boson. A Bethe—Salpeter equation is set up in the ladder proximation. The consequences of the continuity equation are udied in the same approximation and are shown to be fulfilled tomatically only for scalar bound states. A new method is esented for solving the Bethe—Salpeter equation. A spectral pothesis is made for the wave-function which leads to a one- nensional integral equation for the weight function when the rest ass of the bound state is neglected. This integral equation is lved in the Fredholm approximation for a somewhat modified cut- prescription in the scalar case. With the same restriction, the genvalue is found also in the pseudoscalar case. It is shown that e method of solution can be extended to any order in the rest mass the bound state.

448 PROBLEM OF PROVING THE MANDELSTAM REPRESENTATION. R.J.Eden.

ys. Rev. (USA), Vol. 120, No. 4, 1514-18 (Nov. 15, 1960).

It is shown that sufficiency conditions for the validity of the andelstam representation (Abstr. 4941 of 1959) of a collision nplitude can be stated in terms of the location of singularities of s physical branch when one of the energy variables is real and sitive and the second independent energy variable is complex. It also shown that in perturbation theory the real singularities of the ysical branch must correspond to positive Feynman parameters ovided that none of the curves of singularities identified in this ay have turning points in positive spectral regions. The same con- tion will exclude complex singularities in the physical sheet that e connected to the curves of singularities on its real boundary. If ere are any disconnected complex singularities they must corres- nd to complex Feynman parameters. It is concluded that the suffi- ency conditions for the Mandelstam representation are the absence turning points in positive spectral regions and the absence of sconnected complex singularities in the physical sheet. In the ual-mass case these conditions are both necessary and sufficient, d real singularities in the physical sheet can be identified by quiring that the Feynman parameters shall be positive. The con- tions are satisfied by ladder diagrams when there are no anomalous resholds. [It has now been proved that the representation is correct r every order in perturbation theory (see following abstract). The oof requires some of the results of this paper].

449 PROOF OF THE MANDELSTAM REPRESENTATION IN PERTURBATION THEORY. R.J.Eden.

ys. Rev. Letters, Vol. 5, No. 5, 213-15 (Sept. 1, 1960).

Outlines a proof for every term in the scattering amplitude, for system that has no anomalous thresholds. R.J.N.Phillips

450 SOME SINGULARITIES OF SCATTERING ON UNPHYSICAL SHEETS. J.Gunson and J.G.Taylor.

ys. Rev. (USA), Vol. 121, No. 1, 343-6 (Jan. 1, 1961).

For previous work, see Abstr. 12869 of 1960. An investigation the consequences on unphysical sheets of a Mandelstam-type presentation holding for a two-particle scattering amplitude on e physical sheet is described. The domain of analyticity in the ergy and momentum transfer variables is constructed and mpared with perturbation theory. A theorem on multiplication singularities for Legendre polynomial expansions used in this scussion is proved.

451 INVARIANCE AND THE S-MATRIX. II. Y.Takahashi.

clear Phys. (Internat.), Vol. 20, No. 4, 621-9 (Nov. (3), 1960).

For Pt I, see Abstr. 17259 of 1960. A formal method is oposed for handling an interaction, which is not invariant under a rtain transformation. It is proved that a linearly dependent ation of the "invariance deficiencies" yields a selection rule for S-matrix element constructed from the non-invariant inter- tion.

452 STRUCTURE OF THE S MATRIX IN THE PRESENCE OF A BOUND STATE. S.Tani.

ys. Rev. (USA), Vol. 121, No. 1, 346-9 (Jan. 1, 1961).

It is shown that the phase factor associated with the "orthogo- ity phase shift" due to a bound state should be factored out of the natrix. A crucial test of this statement is found in a study of the al state interaction of an inelastic process which ends in a annel involving the bound state. If one assumes that the sum of Born series for the S matrix gives a right answer after the ect of the bound state is separated in terms of the orthogonality ase shift, an agreement with Watson's result obtains only when the natrix has the factored structure.

453 SCATTERING BY A BOUNDED NON-LINEAR SINGULARITY. E.A.Power and I.Saavedra.

Proc. Cambridge Phil. Soc. (GB), Vol. 57, Pt 1 121-30 (Jan., 1961).

An investigation is made of the effect of a nonlinear addition to Schrödinger's equation for s-wave scattering of a beam of particles by a finite region of potential energy. The nonlinear region is bounded and of an especially simple form so that an analytic solution is possible. The R-function for the problem is explicity constructed and some related formulae such as the resonant energies and the scattering length are given. The analytical nature of R as a function of the momentum considered as a complex variable is discussed in relation to causality.

454 A VARIATIONAL PRINCIPLE FOR SCATTERING PHASES. I.C.Percival.

Proc. Phys. Soc. (GB), Vol. 76, Pt 2, 206-16 (Aug., 1960).

A first-order variational principle for a stationary scattering phase is obtained by keeping constant the energy normalization for permitted variations of the wave-function. The principle is used to derive (i) a variational correction to the phase obtained from given approximate wave-functions, (ii) a first-order perturbation theory, (iii) a first Born approximation and (iv) a variational method for obtaining approximate wave-functions analogous to that of Kohn. (i), (ii) and (iii) are more generally applicable than the corresponding expressions for tan δ_l and sin δ_l, where δ_l is the phase, and simple models suggest that they are more accurate than for tan δ_l, but an example indicates that (iv) may be worse than Kohn's variational method. A possible explanation is given. The theory is generalized to many channels. Many complications arise which are absent or trivial for one channel, and the generalization is not complete, since the author is unable to define a stationary phase matrix and the range of application is more limited.

455 MODIFICATION OF EFFECTIVE RANGE THEORY IN THE PRESENCE OF A LONG-RANGE POTENTIAL.

L.Spruch, T.F.O'Malley and L.Rosenberg.

Phys. Rev. Letters (USA), Vol. 5, No. 8, 375-7 (Oct. 15, 1960).

It is pointed out that the usual effective range approximation is valid only when the potential vanishes at infinity faster than any inverse power of r. The case of S-wave scattering from a $1/r^4$ potential (which arises in the scattering of charged particles by a neutral polarizable system) is treated exactly showing the additional $|k|$, k^2, and $k^2 \log|k|$ terms. For higher waves, the expansion for any r^{-n} type potential is of $k^2 \cot\delta$ and not $k^{2L+1}.\cot\delta$. New terms will appear, for example, in nucleon—nucleon scattering due to long-range magnetic interactions. D.W.L.Sprung

456 EXTRAPOLATION METHOD TO DETERMINE DIFFERENTIAL SCATTERING CROSS SECTIONS OF UNSTABLE PARTICLES. M.Nauenberg.

Phys. Rev. Letters (USA), Vol. 5, No. 9, 438-9 (Nov. 1, 1960).

It is shown that the Chew—Low extrapolation procedure for measuring the scattering cross-section for unstable particles is vitiated by the presence of two branch points, which occur when the required differential cross-section is expressed in terms of the extrapolation variable (the momentum transfer) and the variables usually held fixed. This difficulty can be removed by integrating the observed cross-section over scattering angle before making the extrapolation, or by extrapolating in different variables. E.J Squires

457 UNITARITY RELATIONS BETWEEN THE PARAMETERS OF THE SCATTERING MATRIX FOR ELASTIC COLLISIONS OF PARTICLES WITH ARBITRARY SPIN. I.Brendush.

Rev. de Physique (Roumania), Vol. 5, No. 2, 169-80 (1960). In Russian.

The non-relativistic scattering matrix is expressed as the sum of products of spin tensors and orbital functions, the coefficients being functions of energy and angle. Unitarity now implies certain integral relations between these coefficients which could, in principle, be used to help determine the scattering matrix from experiment, but whose complexity has not so far allowed this. J.E.Paton

458 AN EXACT METHOD FOR FINDING THE PHASE SHIFTS OF THE DIRAC'S EQUATIONS FOR NON-SINGULAR POTENTIAL. T.Tietz.

Acta phys. Hungar., Vol. 11, No. 4, 417-18 (1960).

459 PERTURBATION THEORY FOR LARGE QUANTUM SYSTEMS. Yu.L.Mentkovskii.

Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 2(8), 317-21 (Aug., 1960). In Russian.

A new form of the Van Hove—Hugenholtz perturbation theory expansion is proposed. The series obtained differ from the more familiar ones by the simplicity of the energy denominators, a fact which may be useful, for example, in calculating the excited states. The deduction of the indicated expansions is also quite simple. [English translation in: Soviet Physics—JETP (USA)].

460 VALIDITY OF THE TWO-PARTICLE APPROXIMATION IN THE MANY-BODY PROBLEM. K.Kumar.

Nuclear Phys. (Internat.), Vol. 21, No. 1, 99-105 (Nov. (4), 1960).

Brenig's method in the many-body problem is shown to be equivalent to a method of superposition of configurations. Compact expressions are obtained for quantities neglected in the two-particle approximation. The magnitude of corrections to the energies is discussed.

ELEMENTARY PARTICLES

461 NEW ISOTOPIC SPIN SPACE AND CLASSIFICATION OF ELEMENTARY PARTICLES. P.Hillion and J.P.Vigier.

Nuovo Cimento (Italy), Vol. 18, No. 2, 209-28 (Oct. 16, 1960).

The authors start from the new idea that isotopic spin space is invariant under the group of three dimensional complex conjugate rotations and justify this assumption on the basis of a classical model of extended particles described by relativistic rotators. They then express in terms of Euler parameters (a relativistic generalization of real three dimensional Euler angles) the infinitesimal operators of the Lie algebra associated with this group and obtain, in the general space of the corresponding eigenfunctions, finite dimensional sub-spaces associated with irreducible representations of the complex rotation group. In each sub-space one then readily defines a set of "isotopic" or "internal state vectors" corresponding to different types of elementary particle so that each particle is connected with an irreducible representation of this group. In this scheme isotopic strangeness and fermionic numbers correspond to certain infinitesimal rotation operators and one justifies (with new qualitative aspects) the empirical Nishijima—Gell-Mann classification of elementary particles.

462 ON THE MASS SPECTRUM OF BARYONS. L.Łukaszuk.

Bull. Acad. Polon. Sci. Ser. Sci. math astron. phys. (Poland), Vol. 7, No. 8, 515-20 (1959).

An attempt to explain the mass spectrum within Krolikowski's scheme (Abstr. 1080 of 1959), using perturbation theory and assuming a certain simple bare-mass spectrum. J.C.Taylor

463 SPACE—TIME REFLECTIONS, ISOBARIC SPIN AND THE MASS RATIO OF BOSONS. H.Fröhlich.

Proc. Roy. Soc. A (GB), Vol. 257, 147-64 (Sept. 6, 1960).

It is shown that the usual treatment of space—time reflections is unphysical. A new treatment in terms of continuous transformations involving a new angular space (denoted as isospace) is given. This space permits definition of dynamical variables which can be interpreted in terms of isobaric spin, electric charge and mass. Application to bosons results in a mass ratio and isobaric spin assignment in perfect agreement with the empirical values.

464 LIGHT QUANTA AND HEAVY BOSONS. H.Fröhlich.

Proc. Roy. Soc. A (GB), Vol. 257, 283-90 (Sept. 20, 1960).

The new treatment of space—time reflections presented in a recent paper has led to wave equations whose solutions describe π- and K-mesons with correct isobaric spin properties. Generalization of this wave equation now leads to (i) an isobaric spin triplet (π-mesons), (ii) a singlet with zero mass (Maxwell equations, light quantum), (iii) an isobaric spin quadruplet with zero mechanical spin (K-mesons), and (iv) a particle with equal isobaric spin properties, but unit mechanical spin.

465 ON THE VECTOR BOSONS. W.Królikowski.

Bull. Acad. Polon. Sci. Ser. Sci. math. astron. phys. (Poland), Vol. No. 12, 729-31 (1959).

A previous scheme (Abstr. 9207 of 1959) for the elementary particles is extended so as to include photons and the hypothetical vector meson intermediaries in weak interactions. J.C.Taylor

466 NOTE ON THE FORBIDDEN PROCESSES OF THE LEPTONIC DECAYS. T.Adachi and S.Nakai.

Progr. theor. Phys. (Japan), Vol. 22, No. 6, 889-90 (Dec., 1959).

It is assumed that the Fermi interactions are invariant when the strong reflection which includes the strong reflection parity is applied to the fermion field. The arbitrary phase factor of the spinor field is defined as "strong reflection parity" and is taken to be +1 for the nucleon. The corresponding values for leptons are listed. It is shown that the unwanted weak processes $\mu^{\pm} \rightarrow e^{\pm} + e^{\pm} + e^{\mp}$ and $\mu^{-} + p \rightarrow p + e^{-}$ are forbidden. F.Herb

467 MASS DIFFERENCES IN SECOND ORDER PERTURBATION THEORY. A.I.Solomon.

Nuclear Phys. (Internat.), Vol. 21, No. 1, 161-3 (Nov. (4), 1960).

The results of numerical computations of the mass difference of certain elementary particles on the basis of second perturbatio theory are given. The calculations are based on the assumption th the mass splitting is due to the mass differences of the intermediate particles emitted in the self-energy graphs.

468 RELATIONS FOR THE ELECTROMAGNETIC SELF-MASSES OF PARTICLES. W.R.Theis.

Nuclear Phys. (Internat.), Vol. 21, No. 1, 170-6 (Nov. (4), 1960).

Equations for the electromagnetic self-masses of the first order in the fine structure constant are obtained including all non-electromagnetic interactions without approximation.

469 COULOMB DISSOCIATION OF BEAM PARTICLES. M.L.Good and W.D.Walker.

Phys. Rev. (USA), Vol. 120, No. 5, 1855-6 (Dec. 1, 1960).

The possibility of the dissociation of beam particles by the Coulomb field of the nucleus is discussed. The process is very similar in nature to the well-known electromagnetic processes of pair production and bremsstrahlung. Analogous processes might

(a) $\pi^{+} + {}_{Z}N^{A} \rightarrow p + n + {}_{Z}N^{A}$, and

(b) $p + {}_{Z}N^{A} \rightarrow p + \pi^{0} + {}_{Z}N^{A}$.

These processes will probably have a sizeable cross-section for occurrence at energies greater than 74 BeV for (a) and 14 BeV for (b) if Pb is used as the target material. The useful feature of this sort of reaction is that in essence one can do photoproduction experiments on unstable particle targets. (Piccioni has pointed out possibility of disintegrating π-mesons). Cross-section estimates for dissociation can be made using the Weizäcker—Williams approach.

470 DIFFRACTION DISSOCIATION OF BEAM PARTICLES. M.L.Good and W.D.Walker.

Phys. Rev. (USA), Vol. 120, No. 5, 1857-60 (Dec. 1, 1960).

A phenomenon is predicted in which a high-energy particle beam undergoing diffraction scattering from a nucleus will acquire components corresponding to various products of the virtual dissociations of the incident particle, as $p \rightarrow \Lambda + K^{+}$ or $\pi^{-} \rightarrow p + n$. These diffraction-produced systems would have a characteristic e tremely narrow distribution in transverse momentum, and would have all the same quantum numbers as the initial particle i.e., the same spin, isotopic spin, and parity. The process is related to tha discussed in the preceding paper, and has the same effective energ threshold.

471 EFFECT OF TARGET GAS TEMPERATURE ON THE SCATTERING CROSS SECTION. A.Russek.

Phys. Rev. (USA), Vol. 120, No. 5, 1536-42 (Dec. 1, 1960).

If a beam of particles is scattered by a gas or plasma, the differential scattering cross-section that is observed experimenta may, in some cases, be altered a discernible amount by the rando thermal motion of the target particles. In order to explore the feasibility of using this effect as a means of measuring high temperatures, or to correct for the temperature of the target in the event that the desired cross-section must be measured at high peratures, this work presents a theoretical study of the tempera- dependence of the cross-section. A general expression is ined for the observed differential scattering cross-section in laboratory frame in terms of the differential cross-section in centre-of-mass frame for the general case of arbitrary initial ion of the target. Detailed results for the temperature depen- e are given for hard-sphere scattering (which is also applicable w-energy neutron scattering) and for Coulomb scattering, in approximation in which the projectiles are light and rapidly ing, compared to the targets. For hard-sphere scattering the e of equal projectile and target mass is also considered.

472 STATISTICAL ERRORS IN PARTICLE POLARIZATION MEASUREMENTS.

E.J.Burge.

lear Instrum. and Methods (Internat.), Vol. 6, No. 1, 101-2 ., 1959).

The fractional error in polarization measurements for a given ber of incident particles is shown to be very dependent on the ge of azimuthal angle (ϕ) accepted by the detector. A range of ±20° is suggested as a useful maximum. E.J.Burge

473 FURTHER COMMENTS ON ERRORS IN POLARIZATION MEASUREMENTS.

E.J.Burge.

lear Instrum. and Methods (Internat.), Vol. 7, No. 2, 221-2 y, 1960).

Derives a more accurate formula than that previously given (see ceding abstract) and confirms the earlier conclusions.
E.J.Burge

474 A THIN LIQUID HYDROGEN OR DEUTERIUM TARGET.

E.H.Bellamy, W.R.Hogg and D.Miller.

lear Instrum. and Methods (Internat.), Vol. 7, No. 3, 293-6 e, 1960).

The construction and performance of a low background double- led flat liquid hydrogen or deuterium target of precisely known kness is described.

hotons

475 TOTAL COMPTON CROSS SECTION FOR ARBITRARY SPIN.

C.G.Bollini.

s. Rev. (USA), Vol. 121, No. 1, 314-18 (Jan. 1, 1961).

The magnitude of the total Compton cross-section for arbitrary n is calculated in lowest order by using the absorptive part of the ward scattering amplitude and the unitarity property of the S rix. To find the general form (for any spin) of the forward plitude a universal electromagnetic interaction, implying the ue 2 for gyromagnetic ratio, is postulated. The deduced cross- tion contains as special cases the known cross-sections for nless and Dirac Particles. The average of the cross-section r all the possible polarization states of the particle is also per- med. In the high-energy region the cross-section never in- ases faster than linearly with the energy of the photon. If a elopment in powers of the photon energy is made, the first and ond coefficients are found to be spin independent. The coeffi- nt of the square of the energy is proportional to the square of modulus of the spin vector.

476 PHOTON—ELECTRON CORRELATIONS IN DOUBLE COMPTON SCATTERING.

T.K.Radha and R.Thunga.

Phys. (Germany), Vol. 161, No. 1, 20-5 (1960).

The exact matrix element for the production of two circularly rized photons in a double Compton scattering when the initial ton is also circularly polarized is calculated. The differential ss-sections for the various photon—electron polarization corre- ons are obtained for high energy photons, i.e. taking only near vard emission of photons. It is found that, irrespective of the of the initial electron, the cross-section for either right or circular polarization of all three photons is zero under this roximation.

477 THE SPECTRAL SENSIBILITY [SENSITIVITY] OF A MAGNETIC GAMMA-SPECTROMETER IN A PHOTO- ECTRIC METHOD.

E.P.Grigoryev and A.V.Zolotavin.

lear Instrum. and Methods (Internat.). Vol. 7, No. 3, 289-92 e, 1960).

It is shown that by using a cylindrically symmetric source one compensate the influence of the angular distribution of photo- electrons on the determination of relative intensities of γ-rays in measurements with the help of a transversal magnetic spectrometer.

478 BREMSSTRAHLUNG IN THE SECOND BORN APPROXIMATION.

P.Urban.

Acta phys. Austriaca, Vol. 13, No. 4, 496-505 (1960). In German.

The omission of the contribution of a certain graph in a previous paper (Abstr. 1384 of 1954) is corrected. W.A.Hepner

479 HIGH-FREQUENCY REGION OF THE BREMSSTRAHLUNG SPECTRUM.

R.H.Pratt.

Phys. Rev. (USA), Vol. 120, No. 5, 1717-22 (Dec. 1, 1960).

The McVoy—Fano theory (Abstr. 2514, 2516 of 1960) of the connection between the atomic photoelectric effect and the high-frequency region of the bremsstrahlung spectrum is extended to next order in αZ. The contribution from p states is determined and is important in heavy elements. Predictions for the high-frequency limit are in reasonable agreement with experiment. Information is also obtained concerning angular distributions and polarization correlations.

480 SECOND-DIFFERENCE ANALYSIS OF BREMSSTRAHLUNG YIELD CURVES.

K.N.Geller.

Phys. Rev. (USA), Vol. 120, No. 6, 2147-9 (Dec. 15, 1960).

The second-difference weighting function of the bremsstrahlung spectrum obtained from an empirical isochromat at 15.1 MeV and corrected for thick-target effects is shown to behave like a delta function of width approximately equal to the energy interval in analysis. This behaviour greatly simplifies cross-section analysis of bremsstrahlung-induced activation curves when resonance phenomena are present. Application of the method to preliminary yield data for the (γ,n) reaction in nitrogen and oxygen gives good agreement with known level structure.

481 MEASURING THE CIRCULAR POLARIZATION OF INTERNAL AND EXTERNAL BREMSSTRAHLUNG.

S.Galster.

Z. Phys. (Germany), Vol. 161, No. 1, 46-61 (1960). In German.

The polarization of the internal bremsstrahlung γ's was detected by Compton forward-scattering with polarized electrons for three different β-decays: (1) the allowed transition (P^{32}); (2) the unique forbidden transition ($Sr^{90} + Y^{90}$); (3) the forbidden transition with forbidden spectrum (Bi^{210} = RaE). The detected polarization values of P^{32} and ($Sr^{90} + Y^{90}$) agree with the theoretical values for the allowed transitions. The detected polarization values for Bi^{210} are smaller than the theoretical values of the allowed β-transition by a factor of 0.62 ± 0.08. The polarization of the external bremsstrahlung was measured as a function of the atomic number (Z) using thick absorbers. The polarization of the external bremsstrahlung decreases slowly with the increase of the atomic number. The polarization of bremsstrahlung, which was extrapolated to an absorber with atomic number $Z = 0$, is in good agreement with the theoretical values for the infinitively thin absorber.

482 CERENKOV RADIATION BY THE STRAIGHT LINE CHARGE IN THE UNIFORM CIRCULAR MOTION.

T.Watanabe.

Kumamoto J. Sci. A (Japan), Vol. 4, No. 4, 321-5 (Aug., 1960).

EXCITATION OF CHERENKOV RADIATION IN A DIELECTRICALLY-LOADED WAVEGUIDE. See Abstr. 375

Neutrinos

483 RESONANT SCATTERING OF ANTINEUTRINOS.

J.C.Barton.

Phys. Rev. Letters (USA), Vol. 5, No. 11, 514 (Dec. 1, 1960).

Brief note substantially as follows. It has been suggested by Glashow (Abstr. 9333 of1960) that there might be a resonance in the scattering of antineutrinos by electrons which would lead to an appreciable production of μ mesons. It was estimated that (under the hypothesis of an intermediate charged boson of mass m_Z) the antineutrinos in the cosmic radiation would produce a meson flux of from 0.1 m^{-2} day^{-1} (for m_Z = nucleon mass) to 2 m^{-2} day^{-1} for m_Z = K-meson mass); this rate should be independent of the depth below ground and should thus be distinguishable from mesons produced in the atmosphere. While studying the intensity of cosmic radiation at various depths underground, a recorder of geometric area 0.08 m^2 was operated for 21 days at a depth of 5050 m.w.e. No cosmic-ray events were observed. The effective area of the recorder for high energy mesons, which would be accompanied by knockon and pair-produced electrons, was at least 25% greater than the geometric area, so that the meson flux is probably less than 0.5 m^{-2} day^{-1}. According to Glashow's theory this result makes it unlikely that there is a resonance involving a virtual charged boson with mass equal to that of a K meson.

Electrons

484 APPARATUS DRAWINGS PROJECT. REPORT NUMBER 11. CLASSEN'S METHOD e/m OF ELECTRONS APPARATUS.

R.G.Marcley.
Amer. J. Phys., Vol. 29, No. 1, 26-9 (Jan., 1961).

A simple apparatus for an undergraduate laboratory measurement is described. A flanged metal vacuum chamber contains the electrode system, a filament, two adjustable slits, and a collector. Helmholtz coils supplying the magnetic field are mounted externally. Accelerating potentials of 750 to 1500 V and fields of 60 to 70 G are required. The electrode system can be conveniently removed from the chamber for inspection and measurement. When properly adjusted, the apparatus will permit the determination of the ratio e/m to a precision of ±2%.

485 PARTICLE CREATION IN ELECTRON—ELECTRON COLLISIONS.

F.Calogero and C.Zemach.
Phys. Rev. (USA), Vol. 120, No. 5, 1860-6 (Dec. 1, 1960).

Pair production in high-energy electron—electron collisions is studied with special attention given to pion pair production. A method of calculation is formulated which yields results with reasonable directness in the relativistic limit. The orders of magnitude of counting rates for various experimental settings are ascertained. A complete result is obtained for the case in which two pions emerge with equal energies and opposite momenta.

486 SPIN—ORBIT CORRELATIONS IN μ—e AND e^- —e^- SCATTERING.

A.O.Barut and C.Fronsdal.
Phys. Rev. (USA), Vol. 120, No. 5, 1871-4 (Dec. 1, 1960).

The imaginary part of the fourth-order matrix element for the electromagnetic scattering of two fermions gives rise to a small dependence of the cross-section on the quantity $\vec{s}.\vec{p}_1 \times \vec{k}_1$, where $\vec{s}$ and $\vec{p}_1$ are the spin and momenta of one of the initial particles, and $\vec{k}_1$ the momentum of the same particle after scattering. The resulting angular asymmetry can probably be measured. The effect does not occur in the lowest order of scattering.

487 RECENT DEVELOPMENTS OF BETA SPECTROMETERS.

M.Mladjenović.
Nuclear Instrum. and Methods (Internat.), Vol. 7, No. 1, 11-21 (April, 1960).

A review is given of recent experimental and theoretical developments in beta spectrometry. The most critical points for further development of beta spectrometers are briefly discussed. Some new proposals are also mentioned.

488 THE UTILIZATION OF LARGE AREA SOURCES IN β-SPECTROMETERS WITH INTEGRAL RECORDING.

E.Friedländer and E.Ruckenstein.
Stud. Cercetari Fiz. (Roumania), Vol. 8, No. 2, 113-17 (1957). In Roumanian.

Integral equations have been established and solved for the total number of electrons registered, at a given field strength, in an integral β-spectrometer, for the case of a source of finite extension of circular shape.

489 STUDY OF THE LIFETIME OF POSITRONS IN METALS.

N.Longequeue.
C. R. Acad. Sci. (France), Vol. 251, No. 14, 1376-8 (Oct. 3, 1960). In French.

A 500 μC Na^{22} source was used and coincidences counted between an annihilation quantum and a 1.27 MeV quantum emitted along with the positron. Log plots of coincidence rate against time showed an initial peak whose position gave the short time component, followed by a straight line tail whose slope gave the long time component. For non-metals the two components had mean lives of ≅ 1.8 × 10^{-9} and 3 × 10^{-10} sec respectively. For metals the numbers were ≅ 8 × 10^{-10} sec and 10^{-10} sec.

A.Ashmore

490 RADIATIVE CORRECTIONS TO PAIR PRODUCTION AT HIGH ENERGIES

K.Mork and H.Olsen.
Nuovo Cimento (Italy), Vol. 18, No. 2, 395-6 (Oct. 16, 1960).

The calculation reported uses the Weizsäcker—Williams metho to calculate the radiative corrections to the bremsstrahlung and pair production cross-sections. Increased simplicity compared with othe calculations makes angular integration possible.

J.E.Paton

491 DYNAMICS OF INTERNALLY CONVERTED ELECTRON POSITRON PAIRS.

N.P.Samios.
Phys. Rev. (USA), Vol. 121, No. 1, 275-81 (Jan. 1, 1961).

The reactions studied were $\pi^- + p \to n + \pi^0 (\pi^0 \to \gamma + e^+ + e^-)$ and $\pi^- + p \to n + e^+ + e^-$. From a sample of ~15 000 internally converted electron—positron pairs, 7000 were measured, of which 4200 were used in the detailed analysis. The differential distributions in y (the energy partition) and x^2 (the virtual mass of the photon) agree with the theoretical quantum electrodynamic calculations. A measure of the form factor for the $\pi^0 \to 2\gamma$ reaction gave a value $\Gamma(x/\mu) = 1 - (0.24 \pm 0.16)x^2/\mu^2$, where μ is the mass of the pion. It was further demonstrated that the number of events necessary to determine the contribution of the longitudinally polarized virtual γ-rays in the second reaction is of the order of 50 times that in the present experiment.

492 OBSERVATION OF POSITRONIUM REACTIONS IN AQUEOUS SOLUTIONS.

V.I.Gol'danskii, O.A.Karpukhin and G.G.Petrov.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 5(11), 1477-8 (Nov., 1960). In Russian.

The authors make a short criticism of the usual thermodynamical treatment of positron annihilition in aqueous solutions containi additional substances. Then they report the results of a systemati experimental study of the 3γ positron annihilition speed in such solutions, a Na^{22} positron source having been used. The results show that the counting speed decreases quite markedly even at low concentration and this decrease tends to a limit at high concentrations. [English translation in: Soviet Physics—JETP (USA)].

F.Herbu

493 A NOTE ON THE INTERACTION BETWEN NUCLEON AND ANTI-NUCLEON.

A.Ramakrishnan, N.R.Ranganathan and S.K.Srinivasan.
Proc. Indian Acad. Sci. A, Vol. 50, No. 2, 91-4 (Aug., 1959).

The interaction potential is derived by using the Tamm—Dancoff formalism.

494 ON A CONTRADICTION BETWEEN EXPERIMENTAL RESULTS ON NUCLEAR FORM FACTORS AND CERTAI SYMMETRIES OF STRONG INTERACTIONS.

P.Meyer and J.Prentki.
Nuovo Cimento (Italy), Vol. 18, No. 1, 203-5 (Oct. 1, 1960).

It is shown that N—Ξ symmetry implies that the pion contribution to the isoscalar form factor of nucleons vanishes in all orders. Since K mesons seem unable to account for the observed isoscalar form factor this provides evidence against such a symmetry.

E.J.Squires

Nucleons

495 THEORY OF LOW-ENERGY NUCLEON—NUCLEON SCATTERING.

M.L.Goldberger, M.T.Grisaru, S.W.MacDowell and D.Y.Wong.
Phys. Rev. (USA), Vol. 120, No. 6, 2250-76 (Dec. 15, 1960).

The two-nucleon problem is discussed from the standpoint of the double dispersion relations. The analytic structure of partial wave amplitudes is completely analysed. This is greatly facilitated by the use of the Jacob—Wick helicity amplitudes. The programme of generating a set of dynamical equations by use of the unitarity condition is carried out. In the present approximation, only one- and two-pion exchanges are considered; the resulting system of equations should be adequate for energies below about 170 MeV.

problem of computing the deuteron parameters is discussed.
general structure of the more complicated nucleon–antinucleon
em is briefly treated.

otons

496 SPACE AND CHARGE PARITY OF A PROTON–ANTI-PROTON SYSTEM AND ITS TWO-MESON ANNIHILATION.

Shirokov and E.O.Okonov.
eksper. teor. Fiz. (USSR), Vol. 39, No. 2(8), 285-92 (Aug., 1960).
ussian.
If a proton and antiproton are described by the Dirac equation,
$(p, \bar{p})$ system will possess a definite charge and space parity.
check this consequence of the Dirac equation, it is suggested that
$p \rightarrow \pi^+ + \pi^-$ and $\bar{p} + p \rightarrow \pi^0 + \pi^0$ annihilation experiments be
ormed. [English translation in: Soviet Physics–JETP (USA)].

497 INTERPRETATION OF THE BERKELEY ANOMALY IN HIGH-ENERGY P–D COLLISIONS.

ubis and J.L.Uretsky.
s. Rev. Letters (USA), Vol. 5, No. 11, 513-14 (Dec. 1, 1960).
The "bump" observed in the momentum spectrum of mass 3
il nuclei in the range corresponding to double pion production
xplained without invoking a two-pion resonance as favoured by
shian et al. (Abstr. 20213 of 1960). Following these authors, the
rix element is written so as to allow final state p-wave scatter-
of the mesons. In evaluating the transition probability a zero-
ge approximation for the $\pi - \pi$ phase shift is employed. For a
tering length of 2.5 meson Compton wavelengths, the maximum
duction cross-section occurs at about 300 MeV total energy in
two-pion c.m. system. There is a very sharp peak in the recoil
leus momentum spectrum. It is pointed out that this explanation
s not rule out a two-pion resonance at a higher energy, while a
itive scattering length of the size required here could be related
two-pion bound state of mass 225 MeV. D.W.L.Sprung

539.12

498 MEASUREMENT OF THE ROTATION PARAMETER R IN PROTON–PROTON SCATTERING AT 140 MeV.

.Thorndike, J.Lefrançois and R.Wilson.
s. Rev. (USA), Vol. 120, No. 5, 1819-26 (Dec. 1, 1960).
For previous work on p–p scattering parameters at 140 MeV, see
tr. 1661 of 1959; 12926 of 1960. The p–p rotation parameter R
measured at a laboratory energy of 140.5 MeV over a range of
tering angles θ_2 by means of a triple-scattering experiment.
following values were abtained: θ_2(lab) = 15°, −0.252 ± 0.030;
−0.227 ± 0.028; 25°. −0.271 ± 0.035; 30°, −0.146 ± 0.037; 35°,
151 ± 0.055; 40°, −0.047 ± 0.080.

499 PHASE-PARAMETER REPRESENTATION OF PROTON–PROTON SCATTERING FROM 9.7 to 345 MeV.

reit, M.H.Hull, Jr, K.E.Lassila and K.D.Pyatt, Jr.
s. Rev. (USA), Vol. 120, No. 6, 2227-49 (Dec. 15, 1960).
Results of gradient searches for phase parameters by means of
BM-704 machine representing proton–proton scattering are re-
ted on and the procedure used is described. The analysis made
of most available measurements. The number of "measure-
ts" used by the machine was 541. In some cases each "measure-
t" was a composite of two or more measurements found in the
rature. The fits join smoothly to the $^1S_0$ phase-shift energy curve
w 9.7 MeV. A family of fits was obtained employing as a start-
point the extended source + spin-orbit potential representation
w 150 MeV extrapolated to one or another of the several Stapp,
ilantis, Metropolis fits at 312 MeV (Abstr. 3372 of 1957). Other
rches started out with phase parameters corresponding to the
mel–Thaler phenomenological potential. Evidence is presented
e effect that the better fits of both families are essentially the
e. Error limits of phase parameters derived are estimated by
ous procedures. Some of the accumulated evidence for the
icability of the one-pion exchange potential (OPEP) to the calcu-
n of phase parameters for the higher L and J is described and
basis for previously published inferences regarding the spatial
nsion within which the major part of the potential is the OPEP is
strated. In the case of the best fit, tests indicating the existence
tentials for separate J were made showing therefore that there
serious question regarding the energy rates of change of loga-
mic derivatives of radial wave-functions being negative. A brief
discussion of the relationship of this requirement to the meson theory of nuclear forces is included.

Neutrons

500 MEASUREMENTS OF SPATIAL ASYMMETRIES IN THE DECAY OF POLARIZED NEUTRONS.

M.T.Burgy, V.E.Krohn, T.B.Novey, G.R.Ringo and V.L.Telegdi.
Phys. Rev. (USA), Vol. 120, No. 5, 1829-38 (Dec. 1, 1960).

The spatial symmetry properties of the beta decay of the free neutron was examined in a series of experiments. Measurements of angular distributions of the electrons and protons coming from the decay of polarized neutrons have shown that the correlation coefficient between the directions of electron momentum and neutron spin is −0.11 × 0.02 and that between the antineutrino momentum and the neutron spin is 0.88 ± 0.15. The coefficient of the term proportional to the scalar triple product of antineutrino momentum, electron momentum, and neutron spin (which is not invariant under time reversal) of 0.04 ± 0.05. All these results are consistent with the A–V theory of the beta decay. Details of measurement techniques and the method of producing a beam of polarized neutrons are given.

539.12

501 NEUTRON–PROTON POLARIZATION AND DIFFERENTIAL CROSS SECTION AT 128 MeV.

R.K.Hobbie and D.Miller.
Phys. Rev. (USA), Vol. 120, No. 6, 2201-6 (Dec. 15, 1960).

A 42% polarized neutron beam of 128 MeV average energy was used to measure to n–p differential cross-section and polarization. A range telescope detected recoil protons from a liquid hydrogen target placed in the beam. The following values were obtained:

θc.m.	σ	P
169.7	11.37 ± 0.41	+0.002 ± 0.021
159.3	9.08 ± 0.33	−0.045 ± 0.021
149.0	7.30 ± 0.26	−0.061 ± 0.021
138.8	6.28 ± 0.23	−0.072 ± 0.017
128.5	5.20 ± 0.19	−0.016 ± 0.021
118.4	4.29 ± 0.15	+0.054 ± 0.021
108.2	3.45 ± 0.12	+0.052 ± 0.025
98.1	2.83 ± 0.11	+0.186 ± 0.028
88.1	2.61 ± 0.09	+0.275 ± 0.028
78.1	2.74 ± 0.11	+0.384 ± 0.028

The errors quoted do not include the 7% uncertainty in the normalization of the cross-section data or the 8% uncertainty in the normalization of the polarization data.

502 DEFINITION OF THE DIFFUSION CONSTANT IN ONE-GROUP THEORY. N.G.Sjöstrand.

Reactor Science (GB), Vol. 12, No. 4, 151-4 (Aug., 1960).

A one-group transport equation is derived from the general Boltzmann equation with the sole assumption that the neutron velocity spectrum is independent of position and direction. It is shown that with this assumption the correct way to define a diffusion constant is to form averages of the scattering cross-section, not the mean free path, over the neutron spectrum. Conclusions are also drawn regarding the equivalence between moderator systems studied with pulsed neutron sources and critical reactors and regarding possible systematic differences in diffusion constants derived from stationary and pulsed source experiments. An accurate equation for the neutron spectrum is derived, and finally other approaches to the problem are discussed briefly.

503 COMPLETE SPHERICAL HARMONICS SOLUTION OF THE BOLTZMANN EQUATION FOR NEUTRON TRANSPORT IN HOMOGENEOUS MEDIA WITH CYLINDRICAL GEOMETRY.

W.Kofink
Nuclear Sci. Engng (USA), Vol. 6, No. 6, 475-86 (Dec., 1959).

The paper shows that the treatment of the transport equation in cylindrical geometry does not involve essentially more tedious calculations than the treatment in plane geometry. A complete solution is given for homogeneous media including the complementary solutions. Every partial solution contains in its expansion of spherical harmonics some functions of a parameter with appropriate coefficients. It is shown that these functions are Legendre polynomials and

Legendre functions of the second kind as in the case of plane geometry for the "main" solution, and derivatives of these functions for the "complementary" solutions. They are solutions of the recursion relations for the expansion and yield a further recursion relation for the coefficients. Tables of these coefficients are given up to the eleventh spherical harmonic approximation and a general formula is derived for them. Two examples are worked out, a first based upon the supposition of a linearly anisotropic scattering law, and a second in which two higher terms of anisotropy are added to this law.

504 INTERPRETATION OF THERMAL NEUTRON MEAN LIFETIME EXPERIMENTS.

F.Holzer and M.F.Crouch.

Nuclear Sci. Engng (USA), Vol. 6, No. 6, 545-53 (Dec., 1959).

The effects of leakage, detector and source perturbation, and the presence of higher modes in the neutron density distribution on a determination of the mean lifetime of thermal neutrons in water are discussed. The methods used in several recent experiments to minimize these sources of error are analysed, with particular attention paid to the probelm of suppressing the higher modes of the neutron density distribution. The effect of moderator dimensions is presented in terms of mode suppression factors for three characteristic moderator sizes. Finally, the mathematical analysis for a proposed large-geometry, high-precision mean-lifetime experiment is presented, in which the neutron distribution is calculated as a solution to an eigenvalue problem with variable boundary conditions. Three approximations are presented which allow the counter perturbation to be calculated and the mode content controlled.

505 DERIVATION OF THERMAL NEUTRON SPECTRA FROM TRANSMISSION DATA.

E.A.Burke and L.F.Lowe.

Nuclear Instrum. and Methods (Internat.), Vol. 7, No. 2, 193-6 (May, 1960).

A method formerly used for deriving X-ray spectra from transmission data was employed to determine the spectrum of thermal neutrons. In this method a transmission curve of a neutron beam is obtained, a suitable Laplace transform fitted to the curve, and the spectrum derived from the inverse transform. An experimental test yielded results in reasonable agreement with theoretical expectations. The relative simplicity of the equipment and procedures employed should make this method a useful supplement to standard techniques.

506 MONTE CARLO CALCULATIONS OF NEUTRON THERMALIZATION IN A HETEROGENEOUS SYSTEM.

T.Högberg.

Reactor Science (GB), Vol. 12, No. 4, 145-50 (Aug., 1960).

The slowing down of neutrons in a heterogeneous system (a slab geometry) of uranium and heavy water has been investigated by Monte Carlo methods. Effects on the neutron spectrum due to the thermal motions of the scattering and absorbing atoms are taken into account. It has been assumed that the speed distribution of the moderator atoms are Maxwell—Boltzmann in character.

507 EFFECTIVE CADMIUM CUTOFF ENERGIES.

R.W.Stoughton, J.Halperin and M.P.Lietzke.

Nuclear Sci. Engng (USA), Vol. 6, No. 5, 441-7 (Nov., 1959).

Effective cutoff energies for point 1/v absorbers inside of spherical and cylindrical cadmium filters have been calculated for thermal reactor neutrons. The neutron spectrum was assumed to consist of a Maxwellian plus a 1/E component, and the parameters varied were the thickness of filter, the Maxwellian temperature, and the Maxwellian to 1/E flux ratio. Because of the sensitivity of the effective cutoff to Maxwellian flux parameters for thin filters it is recommended that filter thicknesses of about 40 mils be used. Forty-mil filters show effective cutoffs at about 0.50 to 0.55 eV for temperatures up to about 500^0 K (or about 0.045 eV). Effective cutoff energies for boron filters were also calculated for purposes of comparison.

508 A PULSED (d,t) NEUTRON SOURCE.

A.Ádám, L.Bod, Z.Szabó and L.Szeghő.

Acta phys. Hungar., Vol. 12, No. 2, 107-18 (1960).

A 200 kV horizontally-arranged accelerator has been developed and built forproduction of neutrons in the $T^3(d,n)He^4$ reaction. Operating and focusing conditions of the apparatus were investigated. A net ion current of 200-300 μA could be focused on the target. The neutron yield, as measured from a Zr—T target, was found to be (for a clean target) 3×10^7 neutrons/μC.

509 THE UNIT OF NEUTRON FLUX.

R.D.Harrison and N.Thorley.

Nature (GB), Vol. 188, 571 (Nov. 12, 1960).

A new unit the "chad" is proposed where 1 chad ≡ 1 neutron cm^{-2} sec^{-1}.

510 NEUTRON SPECTRA MEASUREMENTS.

R.S.Stone and R.E.Slovacek.

Nuclear Sci. Engng (USA), Vol. 6, No. 6, 466-74 (Dec., 1959).

Thermal neutron spectra have been measured with time-of-flight techniques. Spectra were obtained for pure water and for a nearly homogeneous subcritical assembly where the ratio of therma absorption to high-energy scattering cross-section was ~ 0.3. For each medium, spectra were measured at 298 and 586^0 K. The experimental results are presented and compared with calculated theoretical spectra. The agreement between theory and experiment is excellent for the multiplying media. On the basis of this agreement, one concludes that chemical binding effects in light water play a negligible role in determining the equilibrium neutron spectrum in water assemblies.

511 ON THE EFFECT OF TOTAL REFLECTION ON THE OPTIMUM DIMENSIONS OF COLLIMATORS FOR NEUTRON CRYSTAL SPECTROMETERS AND DIFFRACTOMETERS

P.Szabó.

Nuclear Instrum. and Methods (Internat.), Vol. 6, No. 2, 183-6 (Jan., 1960).

In developing further the considerations of a previous paper (Abstr. 20150 of 1960), one examines the effect that is exercised by the total reflection developing at the walls of primary collimators used in neutron diffractometers and crystal spectrometers on the optimum dimensions of such collimators. The formulae for computation of the intensity transmitted by a single total reflection are given. It is shown that as to the intensity thus transmitted there is an optimum in the dimensions of the collimator which in cases of practical interest is found to be the same as that determined for direct transmission.

512 DETERMINATION OF ABSOLUTE NEUTRON FLUX BY GOLD ACTIVATION.

J.F.Raffle.

Reactor Science (GB), Vol. 10, No. 1-2, 8-13 (July, 1959).

The paper describes a technique for determining the neutron flux in a beam to better than 1% from an absolute measurement of the activity induced in gold foils by neutron capture. The construction of special gridded ionization chambers with B^{10} layers and their calibration in terms of the gold cross-section to form secondary standards is described.

513 DETECTION OF LOW ENERGY NEUTRONS WITH A NaI(Tl) CRYSTAL AND TIME OF FLIGHT.

R.Ballini and S.M.Shafroth.

Nuclear Instrum. and Methods (Internat.), Vol. 6, No. 4, 331-6 (March, 1960).

A NaI(Tl) crystal was substituted for a plastic scintillator in conventional neutron time of flight apparatus. The characteristics this neutron detection system were studied using pulsed low energy neutrons from the $Li^7(p,n)$ reaction. Neutron groups were resolved down to 30 keV with reasonable efficiency. The method should prove useful in studying low energy neutron spectra resulting from nuclear reactions.

514 A MULTI-CHANNEL TIME-OF-FLIGHT FAST-NEUTRON SPECTROMETER.

A.A.Kurashov, A.F.Linev, B.V.Rybakov and V.A.Sidorov.

Atomnaya Energiya (USSR), Vol. 5, No. 2, 135-40 (1958). In Russia English translation in: Reactor Science (GB), Vol. 10, No. 1-2, 85-8 (July, 1959).

The spectrometer described uses the natural modulation of a cyclotron beam. The time analyser operates on the "nonius" principle, and has a channel width of 1 mμsec. There are 256 recording channels, each capable of accepting 2^{16} pulses.

Mesons

515 TENTATIVE COMPOUND MODEL FOR ALL BARYON AND MESONS

A. Ohmae.

Mem. Fac. Engng Hiroshima Univ. (Japan), Vol. 1, No. 2, 103-12 (Dec., 1958).

In the hyper-microscopic world connected with the internal structure of elementary particles, the charge is assumed to have q-number-like character and two "really elementary" particles are introduced which are constituent particles of all baryons or mesons. Furthermore, the concepts of the non-separated state and the separated real particles. The tentative compound model is applied to decay phenomena of the elementary particles are related to the separated real particles. Tentative compound model is applied on the associated production.

516 OBSERVATION OF μ-MESON BURSTS IN A SET OF IONIZATION CHAMBERS.

N.N.Goryunov and G.T.Zatsepin.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No.2(8), 271-5 (Aug., 1960).
In Russian.

Bursts due to high-energy ($E \geq 10^{11}$ eV) μ-mesons moving at a small angle to the horizontal were observed with aid of a set of cubic ionization chambers. It is shown that with a set of ionization chambers similar to that described, but somewhat modified, it should be possible to study the angular distributions of high-energy μ-mesons. [English translation in: Soviet Physics—JETP (USA)].

517 MUON MASS AND CHARGE BY CRITICAL ABSORPTION OF MESONIC X-RAYS.

S.Devons, G.Gidal, L.M.Lederman and G.Shapiro.
Phys. Rev. Letters (USA), Vol. 5, No. 7, 330-2 (Oct. 1, 1960).

A method similar to that employed by Lathrop et al. (Abstr. 20172 of 1960) was used to determine accurately the mass of the μ-meson by critical absorption in lead of X-rays from the 3D-2P transition in μ-mesic phosphorus. The result obtained, $m_\mu/m_e = 206.78^{+0.03}_{-0.02}$, is in good agreement with the prediction of quantum electrodynamics of 206.77 ± 0.01. If it is assumed that these quantities are equal (i.e. that a μ-meson magnetic moment experiment will yield a g-factor in agreement with quantum electrodynamics), the measurement can be used to set limits on the equality of the μ and e charges, namely $e_\mu/e_e = 1 \pm (5 \times 10^{-5})$.

J.D.Dowell

518 DEPOLARIZATION OF NEGATIVE μ MESONS.

R.A.Mann and M.E.Rose.
Phys. Rev. (USA), Vol. 121, No. 1, 293-301 (Jan. 1, 1961).

The depolarization of μ-mesons is discussed in terms of the processes occurring in the formation of μ-mesonic atoms and the subsequent cascade to the ground state. The initial distribution of μ-mesons in capturing states of carbon is deduced. The depolarization due to the capture process is derived in a fashion free of essentially all approximations. The only assumption involved is that the scattering cross-section is such as to randomize the direction of motion prior to capture and this assumption is shown to be well fulfilled. The effect of radiative transitions in producing depolarization is determined with all possible dipole transitions taken into account. Only nuclei with zero spin are treated in detail. The Auger process is included in a schematic fashion which is sufficient for the purpose in hand. It is shown that both radiative and Auger transitions must be included in the discussion of the depolarization processes in the cascade. The theoretical results are compared with experiment, and from the comparison it is concluded that the observed facts are well accounted for.

519 EFFECTS OF THE PION—PION RESONANCE AND THE THREE-PION RESONANCE OR BOUND STATE ON NEUTRAL-PION DECAY.

How-sen Wong.
Phys. Rev. (USA), Vol. 121, No. 1, 289-90 (Jan. 1, 1961).

The dispersion method is applied to the problem of neutral-pion decay. It is shown that a pion—pion P-wave resonance can produce a large effect in the decay matrix element. The contribution is related to the semifundamental constant which determines the rate of photoproduction of pions from pions. The contribution of a strong three-pion state is also considered.

520 ESTIMATE OF THE NEUTRAL π-MESON LIFETIME.

R.F.Blackie, A.Engler and J.H.Mulvey.
Phys. Rev. Letters (USA), Vol. 5, No. 8, 384-5 (Oct. 15, 1960).

Measurements were made on K^+ decays in emulsion by the K_{π_2} mode $K^+ \rightarrow \pi^+ + \pi^0$, followed by the decay of the π^0 to give an electron pair $\pi^0 \rightarrow e^+ + e^- + \gamma$. The velocity and direction of flight of the π^0 are determined by the kinematics of the K^+ decay, and the point of decay of the π^0 is given by the origin of the electron pair tracks. Hence the lifetime can be determined. Analysis of 26 such events yields a mean lifetime of $(3.2 \pm 1) \times 10^{-16}$ sec. R.E.Meads

521 THE INFLUENCE OF A POSSIBLE PION—PION INTERACTION ON THE PHOTOPRODUCTION OF CHARGED PIONS.

B.De Tollis, E.Ferrari and H.Munczek.
Nuovo Cimento (Italy), Vol. 18, No. 1, 198-202 (Oct. 1, 1960).

The formulae derived on the basis of the dispersion relation approach of Chew, Goldberger, Low, Nambu, and Robinson (designated CGLNR) do not give the correct behaviour of the cross-section for the photoproduction of positive pions with energy. However, the most serious discrepancy is given by the π^-/π^+ ratio at 90° which is slowly but steadily decreasing with energy, while the theory predicts a nearly constant value. Better agreement is brought about by taking into account the presence of a possible pion—pion interaction in a resonant $T = 1$, $J = 1$ state. Starting from the Mandelstam representation, Cini and Fubini have shown that the effect of the $J = 1$, $T = 1$ pion—pion resonance is simply to add to the expression of the scattering amplitude of CGLNR a contribution of the form of the lowest order perturbation term with an intermediate "particle" of spin 1 and isotopic spin 1. It is found that the introduction of the pion—pion interaction Λ gives the required decreasing behaviour of the ratio, but the introduction of Λ alone gives a decrease too slow to fit all the experimental points well. The behaviour of the π^+ distribution at 90° is substantially unaltered by the new constants introduced: only the magnitude is affected, but with convenient choice of one of the constants this can be normalized at any value.

J.H.Gunn

522 PION—PION INTERACTION IN ELECTROMAGNETIC PROCESSES.

L.M.Brown and F.Calogero.
Phys. Rev. (USA), Vol. 120, No. 2, 653-8 (Oct. 15, 1960).

The correction to the photon propagator due to the emission of a virtual pion pair is evaluated taking into account the effect of the strong pion—pion interaction in the $J = 1$, $T = 1$ state of the pions recently discussed by several authors. Results are given for different sets of parameters describing the pion form factor, and the possibility of investigating the structure of the form factor by means of electron—electron and electron—positron collision experiments is studied.

523 OPTICAL MODEL ANALYSIS OF NEGATIVE PION—PROTON ELASTIC SCATTERING BETWEEN 1.4 AND 6.8 GeV.

G.Domokos and A.Sebestyen.
Nuclear Phys. (Internat.), Vol. 21, No. 1, 157-60 (Nov. (4), 1960).

Elastic scattering of negative pions on protons is analysed in terms of an optical model. The r.m.s. radius of the absorption region is found to be $\langle r^2 \rangle^{\frac{1}{2}} = (0.521 \pm 0.016) \times 10^{-13}$ cm.

524 HIGH-ENERGY PION—NUCLEUS SCATTERING.

M.A.Baqi Beg.
Phys. Rev. (USA), Vol. 120, No. 5, 1867-70 (Dec. 1, 1960).

It is suggested that an inconsistency in the customary treatment of Pauli principle effects is responsible for the discrepancy between the experimentally observed scattering cross-sections of high-energy pions on nuclei and the values calculated from two-body amplitudes in the impulse approximation. The effect considered, and briefly discussed within the framework of a t-matrix theory, is the inverse eclipse effect noted by Glauber (1958). Results are stated for the optical potential and the effective cross-section and numerical values are quoted for negative pions on C^{12}.

525 PHOTOPRODUCTION OF PIONS ON KAONS.

J.Dufour, M.Gourdin and J.Trotin.
Nuovo Cimento (Italy), Vol. 18, No. 1, 160-77 (Oct. 1, 1960).

In order to study the photoproduction of K-mesons on nucleons it is necessary to study the photoproduction of π-mesons on K-mesons. Three graphs are considered, in the approximation of the lowest mass intermediate states. Because of parity conservation, only the magnetic multipoles need be considered. By retaining only the magnetic dipole transition the two coupled integral equations of Mushkelishvili—Omnes are obtained for the two amplitudes due to the isovector part of the electromagnetic current; an equation of the same type is also obtained for the isoscalar part. These reduce to Fredholm integral equations. Knowledge of the π—K phase shifts permits, in principle, the numerical solution of these equations.

J.H.Gunn

526 PHOTO-MESONS FROM POLARIZED NUCLEONS.

A.Ramakrishnan, S.K.Srinivasan, N.R.Ranganathan and K.Venkatesan.
Proc. Indian Acad. Sci. A, Vol. 49, No. 5, 302-5 (May, 1959).

The cross-sections for the photoproduction of neutral and charged π-mesons by polarized photons from polarized protons are calculated.

C.J.Batty

527 PHOTOPRODUCTION OF CHARGED MESONS FROM DEUTERIUM AND THE π^-/π^+ RATIO.

W.P.Swanson, D.C.Gates, T.L.Jenkins and R.W.Kenney.
Phys. Rev. Letters (USA), Vol. 5, No. 7, 336-9 (Oct. 1, 1960).

A 4 in. liquid deuterium bubble chamber was used to measure the ratio of the cross-sections for the reactions: (1) $\gamma + d \rightarrow \pi^- + 2p$, and (2) $\gamma + d \rightarrow \pi^+ + 2n$ at photon energies between threshold and 194 MeV. By correcting the ratio for final-state Coulomb effects in reaction (1), the results can be directly compared with theory and essentially give information about the reaction $\gamma + n \rightarrow \pi^- + p$. The data are divided into three groups according to the energy of the incident photons, and the corrected ratio shows the expected increase with photon energy predicted by dispersion relations. The general agreement with theory of the absolute values obtained is good if an effect arising from the γ—3π interaction is taken into account. J.D.Dowell

528 THE BEHAVIOUR OF THE TOTAL CROSS-SECTION FOR PHOTOPRODUCTION OF π-MESONS AT HIGH ENERGIES.

E.D.Zhizhin.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 1(7), 219-20 (July, 1960). In Russian.

The total cross-section σ is calculated according to the theory of peripheral collisions (Abstr. 11815 of 1959). It is found that at high energies σ cannot decrease faster than ω_L^{-2}, where ω_L is the energy of the photon in the laboratory system. This contrasts with the result of a statistical theory (Abstr. 3336, 4751 of 1951), where $\sigma \cong \exp(-kE^{1/4})$. [English translation in: Soviet Physics—JETP (USA)]. G.Martelli

529 POSITIVE PION PRODUCTION IN p—p COLLISIONS AT 420 MeV WITH POLARIZED PROTONS.

R.H.March.
Phys. Rev. (USA), Vol. 120, No. 5, 1874-80 (Dec. 1, 1960).

The asymmetry in the production of π^+-mesons in p—p collisions was studied, using a 420 MeV, 62% polarized proton beam from the Chicago synchrocyclotron, with nuclear emulsions as the pion detector. The asymmetry at 65° in the laboratory for the entire spectrum above 20 MeV in the centre-of-mass system is found to be 0.151 ± 0.021, in the direction opposite to the elastic scattering that produced the polarized beam. In the region of the spectrum above 40 MeV, results are consistent with those found by other authors for the reaction $p + p \rightarrow \pi^+ + d$; at lower energies where pions associated with final nucleon p states become predominant, the asymmetry decreases rapidly and may possibly reverse.

530 PION PRODUCTION IN PION—NUCLEON COLLISION WITH ASSUMPTION OF STRONG PION—PION INTERACTION.

D.Ito, M.Yamazaki, T.Kobayashi and K.Mori.
Progr. theor. Phys. (Japan), Vol. 22, No. 3, 448-51 (Sept., 1959).

The strong pion—pion interaction model of Kovacs is a favourable one in that it predicts that large-angle deflection of the nucleons is improbable and that the matrix elements are not strongly dependent on the direction of the emitted pions. Assuming the simplest type of pion interaction and using a perturbational calculation for an incident pion energy of 1.4 BeV, curves are given for the following: (1) angular distributions of nucleons and pions in comparison with experimental results of Eisberg et al.; (2) angular correlation between two pions in comparison with the experimental results of Walker et al.; (3) momentum distributions of nucleons and pions; (4) momentum—angular correlation of emitted pions; (5) comparison of the contributions of the separate partial waves with the phenomenological analysis of Ito and Minami. Better results are expected by a more advanced treatment of the interaction, taking into account the meson cloud around the nucleon. J.H.Gunn

531 TOTAL CROSS-SECTION FOR $\gamma + n \rightarrow \pi^- + p$ NEAR THRESHOLD BY CHEW-LOW EXTRAPOLATION.

W.P.Swanson, D.C.Gates, T.L.Jenkins and R.W.Kenney.
Phys. Rev. Letters (USA), Vol. 5, No. 7, 339-41 (Oct. 1, 1960).

Experimental results for the cross-section in the reaction $\gamma + d \rightarrow \pi^- + 2p$ are extrapolated, as a function of the recoil momentum of one of the protons, to the pole corresponding to the deuteron binding energy. One, two and three parameter forms were used for the extrapolation and the results obtained differed considerably for the three forms. E.J.Squires

532 ON A POSSIBLE ISOTOPIC STRUCTURE OF THE D-PARTICLE.

B.Kuchowicz.
Acta phys. Polon. (Poland), Vol. 19, No. 5, 559-64 (1960).

A charge singlet for the D-particle is proposed. This particle is included into the scheme due to Rayski (Abstr. 5475 of 1960) after a slight modification. Other possibilities within the framework of this scheme are discussed.

533 K_2^0 AND THE EQUIVALENCE PRINCIPLE.

M.L.Good.
Phys. Rev. (USA), Vol. 121, No. 1, 311-13 (Jan. 1, 1961).

It is shown that the existence of the long-lived neutral K meson, and the absence of its decay into two pions, establishes that the gravitational masses of the K^0 and $\bar{K}^0$ are equal to a few parts in 10^{-10} of the K inertial mass. This is of interest since the $\bar{K}^0$ is the antiparticle of the K^0, and is not identical with the K^0. The gravitational mass of such a nonidentical antiparticle has never been directly measured. Also, the $\bar{K}^0$ has opposite strangeness to the K^0. Thus the argument rules out any linear dependence of the gravitational mass on the strangeness quantum number, a point on which all previous experiments say nothing. These observations are in accord with, and serve as a confirmation of, the equivalence principle of Einstein.

534 POSSIBLE EXISTENCE OF $\Delta Q = - \Delta S$ DECAYS.

R.E.Behrends and A.Sirlin.
Phys. Rev. Letters (USA), Vol. 5, No. 10, 476-8 (Nov. 15, 1960).

The possibility that $K \rightarrow 3$ lepton decays are due to pure or dominant $I = \frac{3}{2}$ currents is examined. Inequalities on total and differential decay rates are derived. Exact lower and upper bounds on the $\Delta Q = - \Delta S$ decays $K^0 \rightarrow \pi^+ + e^- + \nu$ in terms of observed lifetimes are exhibited. D.W.L.Sprung

535 OBSERVATIONS ON THE MASS SPECTRUM OF σ MESONS.

N.Fiuciuc and C.Potoceanu.
Stud. Cercetari Fiz. (Roumania), Vol. 9, No. 2, 181-4 (1958). In Roumanian.

By the method of constant sagitta, the masses of the following stopped negative mesons have been determined; 25 σ mesons giving stars with 1, 2 or 3 prongs; 19 σ mesons giving stars with 4 or 5 prongs; 13 π mesons, for comparison, from disintegrations. There are only two particles, a σ_4 and a σ_5 whose masses (determined by the constant sagitta method) are, within the limits of possible significant errors, ~500 m_e. Both tracks are short and gap measurements show them to be pions too.

536 DYNAMICAL CONSEQUENCES OF THE K^+—K^0 MASS DIFFERENCE.

G.Frye.
Nuovo Cimento(Italy), Vol. 18, No. 2, 282-6 (Oct. 16, 1960).

The possibility of using the observed K^+—K^0 mass difference for obtaining information on the $\pi + K$ interaction is investigated. The fraction of the total isotopic vector charge of the K-meson that resides in the two-pion cloud is the crucial parameter. It must have a value greater than unity in order to obtain a simple dynamical origin of the mass difference. Consistency requirements arising from the relation to π—K scattering imply that the fraction must have a value within the interval $-2 \lesssim f_K \lesssim 2$.

537 ON THE POSSIBILITY OF NEUTRAL CURRENTS IN FOUR-FERMION INTERACTIONS.

W.Majewski.
Bull. Acad. Polon Sci. Ser. Sci. math. astron. phys. (Poland), Vol. 8, No. 2, 95-8 (1960).

A discussion whether certain "anomalous" K^+ decays can be interpreted as $K^+ \rightarrow \pi^+ + \nu + \bar{\nu}$. J.C.Taylor

538 ON A QUADRILINEAR K^2—π^2 COUPLING.

G.Costa and L.Tenaglia.
Nuovo Cimento (Italy), Vol. 18, No. 2, 368-80 (Oct. 16, 1960).

The effect is investigated of the direct K—π coupling on the pion—nucleon and kaon—nucleon inelastic scattering. The incident boson is assumed to interact only with the peripheral pions of the nucleon cloud. The inelastic scattering cross-section is expressed, by means of the Chew—Low procedure, in terms of the cross-section for the K—π interaction, averaged over the energy. The reliability of the approximation and the branching ratios of the possible reactions are discussed for the various cases.

539 EFFECTIVE RANGE FOR K^+—NUCLEON INTERACTION FROM DISPERSION RELATIONS.

S.N.Biswas and V.Gupta.
Nuclear Phys. (Internat.), Vol. 21, No. 1, 137-41 (Nov. (4), 1960).

An exact formula for the effective range for K^+—p interaction, in the S-wave approximation, has been deduced using dispersion theoretic techniques. It is shown that if the assumption of zero effective range which is generally used for a phenomenological fit of K–N data, is valid then analysis clearly indicates that the K-meson–hyperon relative parity must be odd (the $\Sigma-\Lambda$ relative parity being even). The contribution of the dispersion integral over the unphysical region has been fully taken into account in the present analysis. A general discussion of the nature of the coupling is given for a non-vanishing but small effective range. The advantage of the use of the effective range formula to determine the sign of the relative parities is also pointed out.

540 INTERACTION OF K^+ MESONS WITH EMULSION NUCLEI; K^+ ENERGY RANGE 140-375 MeV.

B.S.Zorn and G.T.Zorn.
Phys. Rev. (USA), Vol. 120, No. 5, 1898-1913 (Dec. 1, 1960).

Experimental data are presented. From an optical-model calculation based on a Wood–Saxon potential ($r_0 = 1.15\,A^{1/3}$ f, $d = 0.57$ f , the real K nuclear potential V was found to be positive (or repulsive), varying from 18.5 ± 3.3 MeV at the lowest energy to 13.5 ± 5.0 MeV at the highest energy. The value of the imaginary nuclear potential W changed with increasing energy from −12.9 ± 1.4 to −17.6 ± 2.5 MeV. The K--nucleon cross-section was derived from the imaginary nuclear potential and, under the assumption of the independent-particle model of the nucleus, the total K–neutron non-charge-exchange cross-section $\sigma_{Kn}{}^+$ and the charge-exchange cross-section $\sigma_{Kn}{}^0$ were determined. It was found that $\sigma_{Kn}{}^+$ decreases with increasing energy from 12.1 ± 1.6 to 8.1 ± 1.5 mb, whereas $\sigma_{Kn}{}^0$ increases from 4.6 ± 1.2 to 10.3 ± 2.4 mb. A phase-shift analysis using the total cross-sections $\sigma_{Kp}{}^+$ (the K–proton cross-section), $\bar{\sigma}_{Kn}{}^0$, σ_{ub} (the average K–nucleon cross-section), and V gave evidence for P-wave contribution in isotopic spin state T = 0 and permitted an investigation of the angular distribution for K^+–neutron scattering. Charged π-meson production by K^+ mesons was observed, and the K–nucleon cross-section at ~280 MeV K^+ energy was estimated to be $\sim\frac{1}{7}$ mb.

541 A FIXED-SOURCE APPROACH TO SCATTERING OF KAONS. SUPPLEMENT. W.Królikowski.

Bull. Acad. Polon. Sci. Ser. Sci. math. astron. phys. (Poland), Vol. 7, No. 11, 691-3 (1959).

A correction to a previous paper (Abstr. 11397 of 1959).

J.C.Taylor

542 EFFECTIVE RANGE APPROXIMATION FOR SCATTERING OF KAONS WITH SCALAR COUPLING.

W.Królikowski.
Bull. Acad. Polon. Sci. Ser. Sci. math. astron. phys. (Poland), Vol. 7, No. 11, 695-7 (1959).

The effective range approximation is obtained from forward scattering dispersion relations for the $\bar{K}$–N and K–N systems. The formulae are examined for the possibility of a resonance. The pseudoscalar case was studied previously (Abstr. 11397 of 1959).

J.C.Taylor

543 SCATTERING OF KAONS WITH $\bar{K}K\pi\pi$ COUPLING IN THE FIXED-SOURCE THEORY. W.Królikowski.

Bull. Acad. Polon. Sci. Ser. Sci. math. astron. phys. (Poland), Vol. 8, No. 1, 63-6 (1960).

A previous calculation (Abstr. 11397 of 1960) is modified by including a $\bar{K}K\pi\pi$ interaction. It is found that this helps to avoid unobserved resonances in K^+–p scattering. J.C.Taylor

544 POSSIBLE EFFECT OF $\bar{K}$–N REACTIONS ON K–N SCATTERING. R.H.Capps.

Phys. Rev. (USA), Vol. 121, No. 1, 291-3 (Jan. 1, 1961).

Approximate P-wave dispersion relation from K–N scattering are considered, under the assumption that the KΛN and KΣN interactions are of the odd intrinsic-parity, Yukawa type. If the crossing terms (which involve the P-wave $\bar{K}$–N amplitudes) are neglected, the predictions of the equations are contradicted by the experimental evidence. However, the presence of virtual pion–hyperon states may enhance the $\bar{K}$–N amplitudes sufficiently that they play an important role in the equations. It is shown that if the isotopic spin 1, $P_{3/2}$ $\bar{K}$–N absorptive amplitude is particularly strong, the contradiction with experiment may be removed. The possibility of even-parity K–baryon reactions is discussed briefly.

545 K^--MESON CAPTURE BY HELIUM. T.B.Day.

Nuovo Cimento (Italy), Vol. 18, No. 2, 381-94 (Oct. 16, 1960).

Some atomic and molecular processes which occur when K^--mesons stop and are captured in liquid helium are investigated. It is shown that while the K^--meson is in its initially highly-excited atomic states, S-state capture is predominant.

546 BRANCHING RATIOS FOR THE K^- CAPTURE FROM HYDROGEN AT LOW ENERGY. K.Kawarabayashi.

Prog. theor. Phys. (Japan), Vol. 22, No. 3, 451-2 (Sept., 1959).

The author claims that an explanation of the $K^- + p \rightarrow \Sigma^{\pm 0} + \pi^{\mp 0}$ branching ratios may be possible for the appropriate value of the pion–baryon coupling constants. The reason why the global symmetry hypothesis is not compatible with the above reaction ratios is made clear; this conclusion is insensitive to the $\Sigma-\Lambda^0$ mass difference and also to the magnitude of the K–baryon coupling constant.

J.H.Gunn

Hyperons

547 NONLEPTONIC DECAY MODES OF THE HYPERONS. G.Feldman, P.T.Matthews and A.Salam.

Phys. Rev. (USA), Vol. 121, No. 1, 302-3 (Jan. 1, 1961).

An attempt is made to correlate the observed asymetries in hyperon decays and the hyperon decay times using a pole approximation to the decay matrix elements. It is found that a natural correlation is obtained if a near-global relation between pion coupling constants is assumed.

548 (Σ^0,Λ^0) RELATIVE PARITY AND THE DALITZ DECAY OF THE Σ^0 HYPERON. J.Sucher and G.A.Snow.

Nuovo Cimento (Italy), Vol. 18, No. 1, 195-7 (Oct. 1, 1960).

It is suggested that, if a reaction can be found in which polarized Σ^0's are produced, then a measurement of the angular correlation between the spin of the Λ^0 and the plane of the e^-–e^+ pair in the reaction $\Sigma^0 \rightarrow \Lambda^0 + e^+ + e^-$ would be a sensitive test of the (Σ^0,Λ^0) relative parity. About 100 events should provide an unambiguous determination. J.E.Paton

549 $\Sigma^0 \rightarrow \Lambda^0 + e^+ + e^-$ AND THE $\Sigma^0-\Lambda^0$ RELATIVE PARITY. N.Byers and H.Burkhardt.

Phys. Rev. (USA), Vol. 121, No. 1, 281-2 (Jan. 1, 1961).

The $\Sigma^0-\Lambda^0$ relative parity may be measured by observing c correlation of polarizations in the process $\Sigma^0 \rightarrow \Lambda^0 + \gamma$. Internal conversion of the photon into an electron pair (Dalitz pair) serves as an analyser which selects polarized photons. Theoretical results are presented which show that the Dalitz-pair decay mode of polarized Σ^0's may be used to measure the $\Sigma^0-\Lambda^0$ relative parity.

550 DETERMINATION OF THE RELATIVE $\Sigma-\Lambda$ PARITY AND OF THE RATIO OF ASYMMETRY COEFFICIENTS α_Λ TO α_0 IN HYPERON DECAY FROM THE PION-HYPERON RESONANCE. P.Meyer, J.Prentki and Y.Yamaguchi.

Phys. Rev. Letters (USA), Vol. 5, No. 9, 442-3 (Nov. 1, 1960).

Using the fact that there is evidence for the existence of a pion–hyperon resonance Y^* of isospin 1 and mass ~1370, and assuming this resonance to be sufficiently narrow and pronounced, the authors propose to consider the reaction $\pi^+ + p \rightarrow K^+ + Y^{*+}$ (1) (where Y^{*+} has various decay modes). The reaction actually observed is $\pi^+ + p \rightarrow K^+ + \pi + \Lambda\ (\Sigma)$, from which it is possible to pick out the K^+ associated with the resonant channel (1) above. A relation is quoted between the relative $\Sigma-\Lambda$ parity and the sign of the ratio of the polarizations P_Λ/P_Σ from which the relative parity can be deduced if P_Λ/P_Σ is measured. Consideration of the Λ produced in two of the possible decay modes provides a way of measuring α_Λ/α_0.

J.H.Gunn

551 Ξ^- PRODUCTION IN EMULSION BY 1.1 GeV/c K^- MESONS. M. Baldo Ceolin, A.Caforia, O.Fabbri, F.Farina, A.Ferilli, G.Miara and J.Schneps.

Nuovo Cimento (Italy), Vol. 17, No. 5, 804-6 (Sept. 1, 1960).

Among the branches of 1255 stars created by interaction of 1.1 GeV/c K^- mesons with nuclei of the emulsion, 45 tracks were found which decayed into π-mesons. From measurements of the ionization and scattering, and the application of kinetics to the decays it was possible to identify 35 events as Σ hyperon decays and one as a Ξ^- decay. Of the remainder there were six probable Σ hyperons, two probable K^- meson decays, and one probable Ξ^-. An estimate is included of the mean life of the Σ hyperon.

S.J.Goldsack

Deuterons

552 BINDING ENERGY OF THE DEUTERON MEASURED WITH A BENT CRYSTAL SPECTROMETER.

E.L.Chupp, R.W.Jewell, Jr and W.John.
Phys. Rev. (USA), Vol. 121, No. 1, 234-5 (Jan. 1, 1961).

The binding energy was determined by measuring the energy of the neutron—proton capture gamma ray with a 2 m bent quartz crystal spectrometer in the Cauchois geometry. A polyethylene target in the through-tube of a reactor supplied the n—p capture gamma rays. The 411.77 keV gamma ray of Hg^{198} and the annihilation radiation were used to calibrate the spectrometer. The average of the results of four plates gives 2.225 ± 0.003 MeV for the binding energy of the deuteron.

553 CROSS SECTION AND POLARIZATION IN THE PHOTODISINTEGRATION OF THE DEUTERON.

M.L.Rustgi, W.Zernik, G.Breit and D.J.Andrews.
Phys. Rev. (USA), Vol. 120, No. 5, 1881-97 (Dec. 1, 1960).

The differential cross-section and polarization of nucleons from the $H^2(\gamma,n)H^1$ reaction is investigated, arranging calculations by means of the amplitude method. Electric dipole, electric quadrupole, and magnetic dipole transitions are considered taking into account coupling between states with the same J but different L such as produced by the tensor potential. The calculations include the general case of elliptically polarized gamma-rays. Numerical results are obtained for two modified versions of the Signell—Marshak two-nucleon potential. Five approximations have been used to exhibit the effects of the various multipole transitions. The calculations agree with experiment rather well even at energies for which the potential used does not represent scattering data at all perfectly. The significance of polarization measurements is discussed.

Tritons

554 TRITIUM DECAY ENERGY.

W.L.Pillinger, J.J.Hentges and J.A.Blair.
Phys. Rev. (USA), Vol. 121, No. 1, 232-3 (Jan. 1, 1961).

The heat output of tritium was determined by calorimetry as 0.3240 ± 0.0009 watt/gram. This value is about 1 to 4% higher than those previously reported. If the half-life of tritium is 12.43 ± 0.04 years, then its average beta energy is 5.73 ± 0.03 keV.

Alpha-particles

555 INVESTIGATION OF THE $He^3 + H^3$ REACTION.

Li Ga En [Li Ka Yen], G.M.Osetinski, N.Sodnom, A.M.Govorov, I.V.Sizon and V.I.Salatskii.
Zh. eksper. teor. Fiz., Vol. 39, No. 2(8), 225-9 (Aug., 1960). In Russian.

The total cross-section for this reaction was determined for triton energies of 150-970 keV with aid of a thin gaseous target. The total cross-section increases from 3.2 to 63.0 mb. The ratios of the cross-sections for various branches of the reaction were measured as a function of the energy. The decay energy of He^5 into an α-particle and neutron was determined.

556 ELASTIC SCATTERING OF PROTONS BY He^3 AND OF NEUTRONS BY H^3.

M.I.Ali, A.Hossain, M.Islam and A.Q.Sarker.
Phys. Rev. (USA), Vol. 120, No. 5, 1851-4 (Dec. 1, 1960).

The differential scattering cross-sections for the elastic scattering of protons by He^3 and of neutrons by H^3 were calculated at the centre-of-mass energies 7.31, 6.45, 3.72, and 10.72 MeV, respectively, on the basis of nuclear shell model with the spin—orbit interaction term. The calculations were made with a square-well potential and the effect of changing the shape of the well illustrated. The calculated cross-sections with the square-well potential were found to be in better agreement in the backward direction with the measured cross-sections than those with a shaped potential well. The polarization of the scattered particles was calculated so that the theory may be tested by double scattering experiments.

557 CLASSIFICATION OF ALPHA PARTICLE WAVE FUNCTIONS.

L.Cohen.
Nuclear Phys. (Internat.), Vol. 20, No. 4, 690-7 (Nov. (3), 1960).

A classification is given of the functions which can occur in the alpha particle ground-state wave-function. Isobaric spin functions, spin and orbital angular momentum functions, and internal functions are classified according to their behaviour under the permutation group of four particles, and combined to form completely antisymmetric functions. Three S-state functions, eight P-state functions, and six D-state functions are obtained.

558 THE INTERACTION OF 40-160 MeV NEUTRONS WITH HELIUM NUCLEI.

M.Arnold, P.E.Hodgson, D.F.Shaw and D.M.Skyrme.
Nuclear Phys. (Internat.), Vol. 19, No. 5, 500-10 (Nov. (6), 1960).

The collisions of 40-160 MeV neutrons with helium nuclei were observed in a high pressure diffusion cloud chamber in a magnetic field of 12 kG. Results are presented for the angular distribution of elastically scattered neutrons in the energy ranges 40-80, 80-120 and 120-160 MeV. These are analysed using an optical model of the interaction with the Bjorklund—Fernbach radial variation and potentials adjusted to give the measured absorption and total cross section. The calculated distribution falls below the experimental at backward angles due to the neglect of exchange reactions by the optical model. Agreement may be obtained by using an abnormally small value of the diffuseness of the nuclear surface. The energy distribution is given for the identified He^3 recoils resulting from neutron stripping. Although it was not possible to carry out a detailed analysis of the observed inelastic events it is concluded that the inelastic cross-section is approximately constant at about 100 mb over the energy range 80-160 MeV.

559 PHOTODISINTEGRATION OF THE ALPHA-PARTICLE.

T.Sasakawa.
Progr. theor. phys. (Japan), Vol. 22, No. 4, 595-6 (Oct., 1959).

The $He^4(\gamma,p)H^3$ cross-section is calculated using Gaussian type wave-functions for He^4 and H^3, that for He^4 being fitted to the r.m.s. radius. If the proton is assumed to interact in the final state through a square-well potential adjusted to produce a p-wave resonance at maximum cross-section, a good fit is obtained. The conclusions are: (a) He^4 has a $^1P_1$ state at an energy of about 26 MeV above the ground state, and (b) the He^4 wave-functions are consistent with this and other data previously fitted.

I.J.R.Aitchison

560 AN IMPROVED ALPHA-COUNTING TECHNIQUE.

N.A.Hallden and J.H.Harley.
Analyt. Chem. (USA), Vol. 32, No. 13, 1861-3 (Dec., 1960).

A scintillation technique using a ZnS phosphor is described, which exhibits higher efficiency and lower background than the standard techniques. The ZnS sulphide is coated on a Mylar base and disks of the phosphor are applied directly to the sample. Counter efficiencies of about 47% are attained and the background is less than 1 count/hr.

561 THE DISCHARGE CHAMBER DEVELOPED AS AN ALPHA PARTICLE DETECTOR.

L.Colli, M.Fazio and T.Rossini.
Energia nucleare (Italy), Vol. 7, No. 12, 865-6 (Dec., 1960).

A new ionizing particle detector with interesting characteristics has been proposed as a cosmic ray detector (Abstr. 5968 of 1959). A similar instrument built for the study of the detection of particles emitted in nuclear reactions at low energy is described. This detector transforms the track of an ionizing particle into a light-emitting track, directly photographable. An ionizing particle creates a number of electron-ion pairs between two parallel electrodes in a gas atmosphere. A voltage is applied for a very short time, $\sim 10^{-7}$ sec, producing an electric field of a few kV/cm in the space between the electrodes. During the time when the field is present, the electrons are accelerated and in their collisions with gas atoms cause excitation and ionization. The excited atoms decay, emitting light, and the newly-produced electrons amplify the process. In the short time interval in which the field is acting the electrons only drift a few tenths of a millimeter in the direction of the field.

COSMIC RAYS

(Nuclear reactions due to cosmic rays are included under Nuclear Reactions)

562 INTERNATIONAL CONFERENCE ON COSMIC RADIATION. I.Escobar V.

ev. Mexicana Fis., Vol. 8, No. 4, 273-80 (1959). In Spanish.

Review of the conference at Moscow University, 6-11 July, 1959. ee Abstr. 7427 of 1960.

563 THE COSMIC RAY EQUATOR AND THE GEOMAGNETISM. K.Sakurai.

. Geomagn. Geoelect. (Japan), Vol. 12, No. 1, 13-20 (1960).

A theory that the disagreement of the position of geomagnetic ipole equator with that of the cosmic ray equator would be caused y 45° westward shifting of the latter was examined. It is shown, hat the deviation of the cosmic-ray equator from the geomagnetic ipole equator is negligible even if the magnetic cavity is present round the earth's outer atmosphere. The origin of the cosmic-ay equator was examined and it was shown that this equator can be roduced by the higher harmonic components combined with the ipole component of geomagnetism. The relation of the origin of he cosmic-ray equator to the eccentric dipoles, near the outer part f the earth's core, contributing to the secular variation of geoagnetism was considered.

564 PHOTOMETRIC CHARGE DETERMINATION OF RELATIVISTIC HEAVY PRIMARIES IN COSMIC ADIATION. B.Waldeskog and O.Mathiesen.

rk. Fys. (Sweden), Vol. 17, Paper 25, 427-40 (1960).

A photometric method of determining the charge of relativistic eavy primary particles in photographic emulsions is described. orrections for different emulsion effects are applied. The accuracy f the charge determination in the interval $3 \le Z \le 14$ is very good. The standard error corresponds to about one fifth of the distance etween consecutive charges. The method may also be used for igher charges. The charge spectrum is studied in the interval $\le Z \le 14$ in emulsions flown over Texas at 41° geomagnetic latitude. The mean flight altitude was about 29 km corresponding to 14 g/cm^2 verlying atmosphere. The charge calibration is made by δ-ray ounting and by studies of fragmentation of heavy nuclei in the mulsion. An extrapolation of the number of boron particles to the op of the atmosphere shows that there exists a finite flux of these articles in the primary beam. The abundance ratio N_{boron}/N_M alls in the interval 0.13 to 0.25, depending on the fragmentation robabilities used for the extrapolation. The results further show hat the relative frequency of nitrogen nuclei is small compared with he frequency of carbon and oxygen nuclei. These nuclei occur in omparable amounts.

565 DETERMINATION OF THE CHARGE OF RELATIVISTIC HEAVY PRIMARIES IN COSMIC RADIATION BY δ-RAY OUNTING AND A COMPARISON WITH PHOTOMETRIC IDENTIFIATION. O.Mathiesen.

rk. Fys. (Sweden), Vol. 17, Paper 26, 441-54 (1960).

A charge determination of relativistic heavy primaries in the osmic radiation has been undertaken by determining the δ-ray ensity, N_δ, of tracks in nuclear emulsions. The investigation was estricted to particles with well identified charges in the interval $\le Z \le 10$, which made it possible to examine the applicability of -ray counting in this region. The standard error in N_δ was found be greater than expected from pure statistical fluctuations, the oefficient of variation introduced by other sources of error than tatistical ones being 7%. Possible sources of error, which may xplain this increase are discussed as well as different psychogical factors, which affect the reproducibility. The relation beteen N_δ and Z^2 is found to be linear. The results obtained from the -ray counting are compared with photometric measurements and ith other charge spectra based on δ-ray counting.

566 THE ABUNDANCE OF NUCLEI HEAVIER THAN OXYGEN IN THE PRIMARY COSMIC RADIATION.

.Kristiansson, O.Mathiesen and B.Waldeskog.

rk. Fys. (Sweden), Vol. 17, Paper 27, 455-83 (1960).

Photometric measurements were made on 61 tracks of heavy rimary particles ($Z > 8$), which were found in an emulsion stack xposed over Texas at 41° geomagnetic latitude. The measurements ere corrected for different emulsion effects. The tracks were selected according to a track length criterion which states that the tracks to be accepted must be long enough to give a standard error in the determination of the charge not exceeding 0.30 units of charge. The charge calibration was made by δ-ray counting and by studies of break-up events. A small amount of fast but non-relativistic particles were found in the material. These particles have been indentified from measurements of mean track width and rate of change of mean track width along the track. The spectrum shows well-resolved peaks. The following observations are made in the spectrum. The ratio $N(17 \le Z \le 26)/N(9 \le Z \le 16) = 0.48 \pm 0.14$ at the top of the atmosphere. The abundance of odd nuclei is much less than the abundance of even nuclei. Neon, magnesium, and silicon are the most abundant elements and occur with approximately the same frequency. There are few primary particles in the charge region $17 \le Z \le 23$. There are two comparatively large particle groups, namely, chromium and iron of roughly the same size in the very heavy region. No particles heavier than iron have been found. The relative abundance of oxygen, silicon, and iron is discussed and compared with the mean universal abundance.

567 IDENTIFICATION OF NON-RELATIVISTIC HEAVY PRIMARIES IN COSMIC RADIATION BY PHOTOMETRIC MEASUREMENTS IN NUCLEAR EMULSIONS.

K.Kristiansson, O.Mathiesen and B.Waldeskog.

Ark. Fys. (Sweden), Vol. 17, Paper 28, 485-93 (1960).

The possibility is discussed of determining the charge of a non-relativistic heavy primary particle by photometric measurements of mean track width (MTW) and the rate of change of mean track width along the track. The error in the charge determination is sensitive to the length of the track measured and the particle velocity. Correct identification is possible as soon as the total track length is greater than 25 mm and the momentum of the particle p_Z, is less than a value which depends on the charge. The limit is for magnesium $p_{12} \cong 1.2$ GeV/c per nucleon and for iron $p_{26} \cong 1.5$ GeV/c per nucleon. In an interval 1.2-1.7 GeV/c per nucleon for magnesium and 1.5-2.0 GeV/c per nucleon for iron the rate of change of MTW is too small to be used for identifications. If a particle falling in this interval is identified solely from MTW measurements the apparent charge will be one unit too high. For $p_{12} > 1.7$ GeV/c per nucleon and $p_{26} > 2.0$ GeV/c per nucleon correct identification is possible from the MTW value only.

568 INVESTIGATIONS OF AN ARRANGEMENT FOR THE MEASUREMENT OF THE NUCLEON COMPONENT OF COSMIC RAYS. W.Lotz, A.Sittkus and W.Hassler.

Nuclear Instrum. and Methods (Internat.), Vol. 6, No. 4, 296-300 (March, 1960). In German.

A description is given of the neutron intensity monitor on the Schauinsland near Freiburg im Breisgau, Germany. By adding 60 B^{10} detectors to the standard-pile-geometry designed by Simpson et al. it was possible to reduce the statistical error from 0.46 to 0.29% for the hourly mean. The barometric pressure coefficient was $0.755 \pm 0.010\%$ mbar^{-1} in 1957 and 0.73 ± 0.02 in 1958. The median rigidity of the primaries is estimated to be 18 GeV. A method is suggested by which it should be possible to shift the median to lower rigidities.

569 ANGULAR DISTRIBUTION OF JETS PRODUCED BY HEAVY PRIMARIES.

E.Balea, E.M.Friedländer, C.Potoceanu and M.Sahini.

C.R. Acad. Sci. (France), Vol. 251, No. 15, 1487-9 (Oct. 10, 1960). In French.

The jets were observed in G5 emulsion exposed in the stratosphere. They are classified A, B or C according to whether they show one, two or several maxima in their angular distribution. For class B (22 jets) the distribution of energy among the products is shown to be in agreement with the two centre model, the majority of collisions being between individual nucleons and pion clouds. Class C (55 jets) are explained as due to N—N and N—2N collisions, and occur at lower energies ($\gamma_0 \sim 50$ instead of 100). Class A are at still lower energy ($\gamma_0 \sim 25$) and all types of collision appear to be involved.

A.Ashmore

570 THE AZIMUTHAL DISTRIBUTION OF MESON JETS. E.Balea, E.Friedländer and C.Potoceanu.

Stud. Cercetari Fiz. (Roumania), Vol. 10, No. 3, 413-16 (1959). In Roumanian.

The distribution of secondaries in 22 p-jets and 6 α and heavy primary-induced jets was investigated in Ilford G-5 stratosphere-flown plates. A significant deviation from uniformity has been observed only on the proton-induced jets, in good agreement with the existence of a preferential plane defined by the directions of motion of the incoming nucleons before the collision.

571 INVESTIGATION OF AN ELECTRON—PHOTON CASCADE OF MORE THAN 10^{13} eV.
D.M.Haskin, E.Lohrmann, M.W.Teucher and M.Schein.
Nuovo Cimento (Italy), Vol. 17, No. 6, 986-8 (Sept. 16, 1960).

Analysis of a pure electron—photon cascade of 2.3×10^{13} eV very near the shower axis and before the cascade maximum yields good agreement with the shower theory of Nishimura and Kamata (Abstr. 5523 of 1957; 8924 of 1952). E.J.Burge

572 THE NATURE OF SHOWERS GENERATED IN LEAD BY THE PENETRATING COMPONENT OF COSMIC RAYS.
S.Alper, E.Balea, E.Friedländer and M.Mayer.
Stud. Cercetari Fiz. (Roumania), Vol. 9, No. 2, 175-80 (1958).
In Roumanian.

2988 hodoscope records have been analysed in order to obtain comparative information on the multiplicity and angular distribution of the soft component of δ-showers and mixed nuclear showers. It is concluded that the markedly wider angular spread of the latter might provide an effective means of discriminating against δ-showers in devices used to study-high energy nuclear interactions.

573 MEASUREMENTS ON A NUCLEAR INTERACTION OF ENERGY ~4.10^{11} eV. E.Balea and E.Friedländer.
Stud. Cercetari Fiz. (Roumania), Vol. 9, No. 2, 259-68 (1958). In Roumanian.

A 4 + 17 α meson shower registered in a stratosphere-flown emulsion has been analysed with respect to the angular and energetic distribution of its secondaries. The primary energy estimated by several methods turns out to be ~4×10^{11} eV. In the c.m.s., the angular distribution shows no strong anisotropy but only a slight asymmetry, favouring backward emission. Two secondary interactions yield information concerning energy transfer. It seems likely that ~3/4 of the primary energy has been carried away by a single secondary (most probably a neutron).

574 TRANSVERSE MOMENTUM COMPONENT OF STRANGE PARTICLES PRODUCED IN PENETRATING COSMIC-RAY SHOWERS. E.L.Andronikashvili and N.N.Roinishvili.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 2(8), 267-70 (Aug., 1960).
In Russian.

Results are presented of the measurement of the transverse momenta of strange particles. It is shown that the mean value of the transverse momentum of heavy unstable particles is (0.52 ± ± 0.06) BeV/c. Within the limits of experimental error, it is independent of the type of strange particle and of the energy of the primary particle in the range (1 ÷ 10) × 10^{10} eV. [English translation in: Soviet Physics—JETP (USA)].

575 EXTENSIVE AIR SHOWERS AND THE UPPER ATMOSPHERE. C.A.Pearson and S.T.Butler.
Nuvo Cimento (Italy), Vol. 18, No. 2, 251-65 (Oct. 16, 1960).

An attempt is made to explain the solar variations in counting rate of extensive air showers, reported by McCusker, in terms of a tidal change in the height of the first interaction of the primary. It is possible to obtain the very large amplitudes McCusker has found with an amplitude of tidal motion in the ozone layer of between 3 and 10 km, and provided nearly all of the high energy primaries involved are heavy.

576 SINGLY-SCATTERED DELAYED ELECTRONS IN EXTENSIVE COSMIC-RAY AIR SHOWERS. P.J.Eccles.
Proc. Phys. Soc. (GB), Vol. 76, Pt 4, 449-57 (Oct. 1, 1960).

On the basis of population density and delay distribution the majority of the delayed particles, detected by Jelley and Whitehouse (1953), associated with extensive air showers are shown not to be singly-scattered shower electrons. The mean delay of such electrons is 2×10^{-8} sec contrasting with the previously measured value of 14×10^{-8} sec. The detected delayed particles are probably μ-mesons.

577 AN INVESTIGATION OF EXTENSIVE AIR SHOWERS, USING CERENKOV DETECTORS.
H.R.Allan, R.F.Beamish, D.A.Bryant, H.Kasha and R.D.Wills.
Proc. Phys. Soc.(GB), Vol. 76, Pt 1, 1-16 (July, 1960).

A method for studying extensive air showers is described, in which four detectors were used to record the Cherenkov light produced by the shower particles in tanks of water 20 cm deep. The size spectrum was measured for shower sizes between 7×10^5 and 2×10^7 particles, and the results were in good agreement with those of other workers. The lateral distribution function appropriate to the Cherenkov detectors was determined and found to be consistent, in the range 10 m < r < 200m, with the predictions of electron—photon cascade theory.

578 ANGULAR SELECTIVITY OF A GEIGER TELESCOPE ARRANGEMENT FOR COSMIC RAY AIR SHOWERS.
W.M.Layson, J.Malos and D.D.Millar.
Nuclear Instrum. and Methods (Internat.), Vol. 6, No. 2, 179-82 (Jan., 1960).

An arrangement of geiger telescopes for the selection of vertical air showers has been investigated. The arrangement shows little selectivity in responding to near-vertical showers. The experimental results are in good agreement with the calculated angular selectivity. The arrangement is, therefore, not likely to be of great value in looking for anisotropy in the high energy primary cosmic radiation.

579 INCREASE IN THE INTENSITY OF COSMIC RADIATION ON MAY 4th, 1960.
P.L.Marsden, J.B.Crowden and C.J.Hatton.
Nuovo Cimento (Italy), Vol. 17, No. 6, 977-9 (Sept. 16, 1960).

Reports the pressure-corrected intensity record obtained between 0300 and 2200 UT and, separately, between 1001 and 1216 UT. Between 1033 and 1037 h, the intensity appears to have risen by more than two standard deviations above normal, overlapping the first period of increase in the record from Deep River. The peak intensity at both stations occurred at the same time. The correspondence of, and the differences between, the data of Leeds and Deep River are discussed. E.W.Kellermann

580 THE PREDECREASE OF COSMIC RAYS IN PERIODS OF MAXIMUM SOLAR ACTIVITY (APRIL 1957 - DECEMBER 1958). J.P.Legrand.
Ann. Geophys. (France), Vol. 16, No. 1, 140-2 (1960). In French.

The cosmic radiation predecrease event, displayed during the continuous measurements carried out in the course of the International Geophysical Year, revealed the presence of particularly active sunspots on the east limb of the sun. The author gives a description of this event accompanied by several examples of correlations.

THE APPEARANCE OF COSMIC RAYS IN THE "PINCH EFFE IN SOLAR FLARES. See Abstr. 26

581 A NEW KIND OF COSMIC-RAY MOMENTUM SPECTRO GRAPH. O.C.Allkofer.
Atomkernenergie (Germany, Vol. 4, No. 10, 389-95 (Oct., 1959). In German.

The instrument is for measuring the momentum spectrum of and the positive excess in cosmic rays. The particles are registered by parallel-plate spark counters, three of which are placed above the magnetic field and three below. When a coincidence occurs the sparks are intensified electronically and photographed. The particles are deflected by a permanent magnet: pole face area 5×20 cm^2; distance between the poles, 2.5 cm; magnetic field strength, 4000 Gauss.

NUCLEUS

582 THEORY OF PERTURBED MULTIPLE CORRELATION
V.Gillet.
Nuclear Phys. (Internat.), Vol. 20, No. 4, 561-84 (Nov. (3), 1960).
In French.

Techniques using irreducible tensorial sets for the calculation of multiple correlated processes are extended to the case when the degeneracies of one or several component states are removed. Th irreducible representation of an operator acting on a state perturb through an interaction with a classical or quantal system is first given in a quite general form. The irreducible product of two operators is then easily generalized when one of the operators is acting on a space of non-degenerate states, the states of the tensor product space being non-degenerate also. This permits the construction of the most general density matrices for perturbed nucle states prepared from perturbed states initially oriented through th absorption or the emission of a radiation of known polarization. Provisions are also made for taking into account any partial depolarization in external fields of the incident or emitted particles before absorption or detection. A detailed discussion is made of perturbed double and triple nuclear correlations, the polarizations of the nuclear states and of the absorbed (or emitted) radiations being specified (or analysed), the perturbing systems being oriented or not. For double angular distributions with axial measurements only, well-known results are obtained. The infinite limit is discussed in detail; in particular, for non-oriented perturbing fields, the residual anisotropy, independent of the orientation of the observation plane (the "hard core" of double angular correlations), is calculated for triple correlation processes; it is shown to be a function of the multipolarities of the intermediate radiation except in the case of axial perturbing fields.

583 INCLUSION OF HOLE MOTIONS IN THE BRUECKNER THEORY.

F.Iwamoto.

Progr. theor. Phys. (Japan), Vol. 22, No. 6, 903-5 (Dec., 1959).

It is shown that the effect of the motion of holes can be included in the Brueckner method by replacing, in the Bethe—Goldstone equation, the operator Q which projects outside the Fermi sea by Q-P, where P projects inside the Fermi sea. An interpretation is given for the solutions of this modified equation. A.M.Green

584 TWO-BODY CLUSTER STATES IN NUCLEI.

G.C.Phillips and T.A.Tombrello.

Nuclear Phys. (Internat.), Vol. 19, No. 5, 555-78 (Nov. (6), 1960).

A number of experimental results for nuclear states are cited that require a description of the nucleus as the interaction of two clusters of nucleons. The types of experiments that yield information about states of two-cluster parentage are considered. The clusters identified and discussed consist of such bodies as deuterons, excited deuterons, α-particles, tritons, helium-3, and nuclei in an excited state such as Be^{8*} and C^{12*}. The general nature of the nuclear forces necessary to produce clustering is discussed, and a phenomenological model describing these cluster states in terms of coupled Schrödinger equations is presented. The model is compared with other current models of nuclear structure. Several definite predictions of the model for the dynamical behaviour of nuclear systems are given.

585 A TWO-BODY CLUSTER MODEL OF THE NUCLEUS.

T.A.Tombrello and G.C.Phillips.

Nuclear Phys. (Internat.), Vol. 20, No. 4, 648-62 (Nov. (3), 1960).

Calculations are presented for coupled Schrödinger equations which develop the detailed behaviour predicted by the two-body cluster model described in a preceding paper. The results show that: (1) narrow resonances in the scattering cross-section may be quantitatively described by this model; (2) the cross-section in the neighbourhood of the threshold of another channel shows the Wigner cusp; and (3) the configuration mixing of bound states is a necessary consequence of the model. As an example, the model is used as a means of parameterizing the lowest $J = \frac{5}{2}^+$ states in C^{13}. This method allows a fit to the scattering phase shift and the level structure, at the same time making a definite prediction of the fractional parentage of the $\frac{5}{2}^+$ bound state.

586 MANY-BODY PERTURBATION METHODS IN A SOLUBLE MODEL.

A.Katz.

Nuclear Phys. (Internat.), Vol. 20, No. 4, 663-89 (Nov. (3), 1960).

It is pointed out that because statistics should not be obeyed in Goldstone's perturbation expansion there exist two-body contributions from diagrams other than ladders. The role of diagrams with "wrong" statistics is investigated in a model in which the perturbation is a single particle potential. A summation of all diagrams is carried out in this model and compared to the sum of all ladders. It is found that the "wrong statistics" contributions are important in deciding the region of convergence of the series and the location and nature of the singularities which limit it. While the region of convergence of the series of ladders is limited by a pole on the real axis, the radius of convergence of the complete series (which is smaller) is marked off by the two branching points off the real axis. The formal sum of all diagrams displays a finite discontinuity at that point of the real axis where the ladders have a pole, thus changing from one branch to another. Each branch can be continued analytically through this discontinuity which is not a singularity of either branch. The ladders approximate only one branch, turning the finite discontinuity into a pole and thus one branch corresponding to the Cooper state, is lost. The remaining branch is described quite well by Brueckner's ladders even outside the region of convergence of the power series. It corresponds to the "normal" state. In the case of two-body interactions with short range and low density the most important contributions with wrong statistics are the two-body contributions of "many-body diagrams". Their inclusion is equivalent to using the Cooper type solution of a Bethe—Goldstone equation.

587 PROPER FREQUENCIES OF THE COMPRESSIBLE NUCLEUS IN AN UNSTATIC STATISTICAL MODEL.

I.Brănduş and A.Săndulescu.

Stud. Cercetari Fiz. (Roumania), Vol. 8, No. 4, 433-44 (1957). In Roumanian.

Proper frequencies of the compressible nucleus are calculated by dynamizing its statistical model, as was done by Bloch (1933), in an analogous way, for the statistical model of the atom. To this purpose, it is assumed that the excitation energy of the nucleus does not give rise to thermic movements but leads to an ordered movement that can be treated in a hydrodynamical manner. The effect of this movement is the perturbation of the mass density of the excited nucleus. When the action integral, with an advisable Lagrangian — assuming the ratio of neutrons and protons to be constant in the nucleus — is a minimum, one obtains the equation for the density perturbation term. In search of the monochromatic oscillations, one determines their proper frequencies from the boundary condition at the nucleus surface of the equilibrium between the inner pressure of the nuclear fluid and the one created by the surface tension. The results are in quantitative agreement with the experimental data.

588 GROUND STATES OF ODD—ODD NUCLEI.

A.de-Shalit and J.D.Walecka.

Phys. Rev. (USA), Vol. 120, No. 5, 1790-2 (Dec. 1, 1960).

The spectrum of odd—odd nuclei is investigated with a general interaction of the type $V_0 + \sigma_1.\sigma_2V_1$. It is shown that an inspection of the properties of some Racah coefficients is enough to determine the ground-state spin for particle—particle or hole—hole configurations in most cases. The results agree qualitatively with empirical evidence summarized by Brennan and Bernstein (Abstr. 20325 of 1960) if V_0 and V_1 are both attractive; this agreement is insensitive to the range and other details of either V_0 or V_1.

589 PROPERTIES OF FINITE NUCLEI.

K.A.Brueckner, A.M.Lockett and M.Rotenberg.

Phys. Rev. (USA), Vol. 121, No. 1, 255-69 (Jan. 1, 1961).

The properties of O^{16}, Ca^{40}, and Zr^{90} are determined, using the Brueckner—Gammel—Weitzner theory of finite nuclei (Abstr. 4261 of 1958). Self-consistent solutions of the Hartree—Fock equations as modified by Brueckner and Goldman are obtained. The properties computed include binding energy, mean proton and neutron radii, separation energies, spin-orbit splittings, nonlocal and state-dependent single-particle potentials, surface depth of density and potentials, potential-density relation. The predictions of the theory are in semiquantitative agreement with experiment.

590 ON NEUTRON-DEFICIENT ISOTOPES OF LIGHT NUCLEI AND THE PHENOMENA OF PROTON AND TWO-PROTON RADIOACTIVITY.

V.I.Goldansky.

Nuclear Phys. (Internat.), Vol. 19, No. 5, 482-95 (Nov. (6), 1960).

Application of isobaric invariance principles to light nuclei leads to a very simple relation between the Z-th proton binding energy E_p in nucleus 1 (${}_ZM_N{}^A$) and the Z-th neutron binding energy E_n in the miror nucleus 2 (${}_NM_Z{}^A$). With an accuracy of the order of a few per cent their difference $E_{n2} - E_{p1} = \Delta E_{np}$ is independent of N for a given Z and is given by

$$\Delta E_{np} \cong E_n({}_ZM_Z^{2Z}) - E_p({}_ZM_Z^{2Z}) \cong 1.2\frac{Z-1}{(2Z-1)^{1/3}},$$

which is more correct than the usual expression $1.2\,(Z-1)/(Z+N-1)^{1/3}$. By exploiting this fact one can predict the existence and properties of almost ninety new neutron-deficient isotopes of light nuclei (up to $Z = 34$) and establish the limits of stability of the isotopes with respect to decay with proton emission. Among the specific properties of neutron-deficient isotopes, proton and two-proton radioactivity effects which may occur are of special interest. Some nuclei are indicated in which these effects may be observed. The main features of a very unusual phenomenon of two-proton radioactivity are discussed.

591 COULOMB ENERGIES OF CLOSED-SHELL NUCLEI FROM SHELL-MODEL WAVE FUNCTIONS.

N.V.V.J.Swamy, V.K.Kembhavi and D.G.Galgali.
Phys. Rev. (USA), Vol. 120, No. 6, 2069-71 (Dec. 15, 1960).

Using harmonic oscillator wave-functions, the Slater integrals are evaluated and expressed in the form of summation formulae. The Coulomb energies of seven closed-shell nuclei are estimated using these integrals. These estimates are compared with those based on a statistical model and a trapezoidal model. The influence of exchange energy on the Coulomb radius of a nucleus is shown to be sensitive to the model used. Although the $Z^{4/3}$ variation of exchange energy appears to be a suitable characterization, present estimates require a larger multiplying constant in the usually accepted expression for the exchange energy. The direct and "net" energies, computed from the three models, show very good agreement.

592 SPIN-ORBIT COUPLING FOR SPIN-1 PARTICLES.

G.R.Satchler.
Nuclear Phys. (Internat.), Vol. 21, No. 1, 116-27 (Nov. (4), 1960).

A one-body spin-orbit potential for spin-1 particles may contain, in addition to the familiar vector term $1 \cdot s$ used with spin-$\frac{1}{2}$ particles, certain tensor terms T. The T may be constructed from the position, momentum and angular momentum vectors of the particle. Time reversal invariance cannot be demanded if a complex potential is allowed, but the requirements of parity conservation and symmetry of the scattering matrix allow only three forms of T. Only one of these remains diagonal in the orbital angular momentum. A simple model illustrates the possible origin of a tensor coupling for deuterons. The implications for the scattering and polarization of spin-1 particles is discussed.

593 NUCLEAR SPIN AND MOMENTS OF 14 hr Ga^{72}.

W.J.Childs, L.S.Goodman and L.J.Kieffer.
Phys. Rev. (USA), Vol. 120, No. 6, 2138-46 (Dec. 15, 1960).

The hyperfine structure of the 14 hr isotope Ga^{72} was investigated by use of atomic-beam magnetic-resonance techniques. The nuclear spin is found to be 3, the magnetic dipole moment $\mu_I = -0.132196 \pm 0.000013$ n.m. (subject to correction for a possible hyperfine anomaly), and the electric quadrupole moment $Q = +0.718 \pm 0.007$ barn.

594 SPINS OF THE ISOMERIC STATES OF Hf^{178} AND Hf^{180}.

M.Deutsch and R.W.Bauer.
Nuclear Phys. (Internat.), Vol. 21, No. 1, 128-32 (Nov. (4), 1960).

The 4.8 sec state of Hf^{178} and the 5.5 h state of Hf^{180} are shown by angular correlation measurements to have spin J = 8.

595 NUCLEAR SPINS OF THULIUM-166 AND 167.

J.C.Walker and D.L.Harris.
Phys. Rev. (USA), Vol. 121, No. 1, 224-7 (Jan. 1, 1961).

The spins of 7.7 hr Tm^{166} and 9.6 day Tm^{167} were measured by the atomic-beam magnetic resonance method. Spin values are Tm^{166}, I = 2; Tm^{167}, I = $\frac{1}{2}$.

596 QUENCHING OF MAGNETIC MOMENTS IN NUCLEI.

S.D.Drell and J.D.Walecka.
Phys. Rev. (USA), Vol. 120, No. 3, 1069-78 (Nov. 1, 1960).

Starting from the premise that with modern dispersion-theoretical techniques one has a reliable method for calculating the anomalous magnetic moment of a nucleon, the authors have calculated the modification or "quenching" of this moment for a nucleon in nuclear matter. The effect considered is due to the fact the nucleons are not allowed by the exclusion principle to recoil into states already occupied by other nucleons in the nucleus. The technique used in the calculation is to sum all the Feynman diagrams that are included in the dispersion-theory calculation of the single-nucleon moment. The nucleon propagator is then written as a sum over states and those states are removed in which the nucleon is inside the Fermi sea. The result is that the anomalous moment is reduced by ~7%.

597 MAGNETIC RESONANCE DETERMINATION OF THE NUCLEAR MOMENT OF TANTALUM-181 IN $KTaO_3$.

L.H.Bennett and J.I.Budnick.
Phys. Rev. (USA), Vol. 120, No. 5, 1812-15 (Dec. 1, 1960).

The nuclear magnetic moment of Ta^{181} is found from the nuclear magnetic resonance of Ta^{181} in $KTaO_3$. The uncorrected value of the moment is 2.340 ± 0.001 n.m. Consideration of diamagnetic shielding effects and a possible second order paramagnetic correction leads to the estimated value of $\mu = 2.35 \pm 0.01$ n.m.

NUCLEAR MAGNETIC DIPOLE MOMENTS OF THE STABLE ISOTOPES OF EUROPIUM. See Abstr. 804

NUCLEAR QUADRUPOLE MOMENT OF Fe^{57m}. See Abstr. 795

598 FORM FACTORS OF THE NUCLEUS ^6Li.

D.F.Jackson.
Proc. Phys. Soc. (GB), Vol. 76, Pt 6, 949-58 (Dec. 1, 1960).

The experimental results for the elastic scattering of high-energy electrons from Li^6 were fitted using a charge distribution derived from a smoothed finite potential $V(r) = -V_0 + \frac{1}{2}Kr^2$, $r < r_0$ and $V(r) = -Ae^{-\mu r}$, $r > r_0$, which had identical parameters for s- and p-nucleons. An r.m.s. radius of 2.72 ± 0.08 fermi and a centra nuclear density of 0.14 ± 0.01 particles per cubic fermi were obtained. The form factors for inelastic scattering were calculated for three models which fitted the elastic scattering and it appeared that the inelastic scattering was much more sensitive to choice of parameters. The total energy of the Li^6 nucleus was calculated on the independent-particle model, including a correction for the spurious energy of the centre of mass.

599 THE MÖSSBAUER EFFECT.

H.Lustig.
Amer. J. Phys., Vol. 29, No. 1, 1-18 (Jan., 1961).

Reviews for nonspecialists the recent discovery and several important applications of recoilless gamma-ray fluorescence. The importance of the fluorescence technique and its limitations, before Mössbauer's discovery, are discussed. Mössbauer's pioneering experiments are briefly described and Lipkin's simple theoretical explanation of recoilless gamma-ray emission is presented. From among the large number of recent experiments which make use of the Mössbauer effect, two groups are selected for discussion. The first is concerned with the discovery of nuclear and magnetic properties of Fe^{57}; the other, with a test of the principle of equivalence in general relativity, by a measurement of the gravitational shift in the frequency of radiation.

600 THE MÖSSBAUER EFFECT. A CONFERENCE REPO

D.S.Lieberman and E.Lüscher.
Phys. Today (USA), Vol. 13, No. 11, 20-2 (Nov., 1960).

The conference was held at the University of Illinois on 5-6 June, 1960. Over 80 physicists attended from 9 countries. Tl reported on their most recent, unpublished experiments and discussed ideas for future research in the field of recoilless gamma ray absorption.

601 RESONANT SCATTERING OF THE 14 keV IRON-57 γ-RAY, AND ITS INTERFERENCE WITH RAYLEIGH SCATTERING.

P.J.Black and P.B.Moon.
Nature (GB), Vol. 188, 481-2 (Nov. 5, 1960).

The very narrow 14 keV line discovered by Mössbauer, in whi a substantial part of the radiation is unaffected by recoil or therm broadening, was used for investigating the coherence of the scatte radiation. As yet, the measurements are not detailed enough to determine what percentage of coherence exists. F.A.Sanders

602 EXPERIMENTAL INVESTIGATION OF PARITY CONSERVATION IN THE 14.4 keV GAMMA TRANSITION I Fe^{57}.

L.Grodzins and F.Genovese.
Phys. Rev. (USA), Vol. 121, No. 1, 228-9 (Jan. 1, 1961).

An experiment using recoilless resonance scattering on the 14.4 keV M1 gamma rays of Fe^{57} was performed to set a limit on the degree of parity impurities in the nuclear states involved. Th anisotropies of the $\Delta m = \pm 1$ gamma-ray transition rates were exa ined towards and away from the direction of nuclear polarization. The use of recoilless resonance scattering allows the problem to so overdetermined that instrumental anisotropies could be cancell by appropriate summing of data. No parity-nonconserving anisotropy was observed. Taking into account the slowness of the M1 t sition compared to a parity-admixed E1 transition of single-parti speed, a factor of 100 in amplitude, the limit on , the relative strength of a parity-admixed wave-function, is $\mathfrak{F} \leq 10^{-5}$.

603 FREQUENCY DISTRIBUTION OF RESONANCE LINE VERSUS DELAY TIME.

C.S.Wu, Y.K.Lee, N.Benczer-Koller and P.Simms.
Phys. Rev. Letters (USA), Vol. 5, No. 9, 432-5 (Nov. 1, 1960).

The unusual frequency sensitivity of the Mössbauer effect in Fe^{57} was used to investigate the dependence of the resonant frequ spectrum upon the duration of the wave train of the unsplit 14.4 keV level. The apparent width of the main resonance line was initially very broad and then compressed as the duration of the delayed time increased, and also the absorber behaved as a resonant filter in good agreement with the theoretical predictions.

E.A.Sanderson

604 A HYPERFRAGMENT ANALYSIS PROGRAMME FOR THE BULL-GAMMA A.E.T. COMPUTER.
V.Gorgé, W.Lind and A.Mercier.
Arch. Sci. (Switzerland), Vol. 13, No. 1, 139-41 (Jan.-March, 1960).
In French.

Describes briefly the main features of a computer programme designed to calculate the binding energies of hyperfragments for a given number of assignments for the decay products, the number of which is restricted to a maximum of five. S.J.St-Lorant

605 ON THE π^+ DECAY OF A HYPERFRAGMENT.
A.Deloff, J.Szymański and J.Wrzecionko.
Bull. Acad. Polon. Sci. Ser. math. astron. phys. (Poland), Vol. 7, No. 8, 521-6 (1959).

The relative frequency of π^+ to π^- decay of hyperfragments is calculated assuming a virtual $\Lambda \to \Sigma^+ + \pi^-$ exchange inside the hyperfragment preceding the decay of the hyperon whilst in the Σ^+ state. C.J.Batty

606 HYPERFRAGMENT PRODUCTION IN K^--MESON ABSORPTIONS AT REST IN NUCLEAR EMULSIONS. NON-MESIC DECAYS. J.Sacton.
Nuovo Cimento(Italy), Vol. 18, No. 2, 266-81 (Oct. 16, 1960).

The results of the analysis of 78 non-mesic hyperfragments including double centred stars produced in K^--meson absorptions at rest are given. The Z-spectrum of the hyperfragments is studied. 12 decays are uniquely identified and in 6 other cases the charge of the hyperfragment unambigously determined. For the remaining events only limits could be put to the charge of the hyperfragment. Combining the charge distribution established here with that obtained for the mesic hyperfragments in a previous investigation, one can obtain the non-mesic to mesic decay ratio as a function of Z.

607 SEARCH FOR Σ^- HYPERFRAGMENTS.
R.G.Ammar, N.Crayton, K.P.Jain, R.Levi Setti, J.E.Mott, P.E.Schlein, O.Skjeggestad and P.K.Srivastava.
Phys. Rev. (USA), Vol. 120, No. 5, 1914-16 (Dec. 1, 1960).

A systematic search was undertaken for possible Σ^- compounds produced by K^- captures in nuclear emulsion. Mass determinations were performed on (a) 15 decays in flight into a charged pion and (b) 84 events resulting in capture configurations; the number of these events produced in single-nucleon K^- captures is estimated to be >32 but <71. All events of type (a) and all but 4 of type (b) are consistent with the interpretation as Σ^-. The 4 events are discussed in detail and it is concluded that, although the $(\Sigma^- n)$ interpretation cannot be ruled out for 3 of them, in no case is the identification unequivocal.

Energy Levels

608 NUCLEAR E1 PEAK ENERGIES.
J.H.Carver and D.C.Peaslee.
Phys. Rev. (USA), Vol. 120, No. 6, 2155-61 (Dec. 15, 1960).

The peak energies E_g of electric dipole giant resonances in photonuclear reactions considerably exceed the shell-model spacings E_s in the same nuclei: the discrepancy $\delta = (E_g - E_s)/E_s$ is of order unity, although the giant resonances are supposed to arise mainly from transitions of nucleons between successive shells. The present note attempts to understand δ by noting that $|E_g - E_h| \ll E_g$ and considering sum rule expressions for the harmonic energy E_h. These sum rule expressions are well known to yield $E_h = E_d + E_x$, where E_x is special to the E1 operator and the charge exchange component of nuclear forces. Theoretical and empirical arguments are adduced that $(E_g - E_s)$ comprises mainly E_x, plus two secondary corrections which happen practically to cancel. Comparison with experiment gives a constant $E_x \cong 8$ MeV and thence a satisfactory account of δ. Previous discussions of δ appear to have neglected E_x and hence have failed to obtain even the right order of magnitude of δ or real nuclei. The use of a constant E_x also allows an improved it to the curve of $\int \sigma dE$ as a function of A. It is pointed out that the value of E_x is comparable in significance with the average nuclear potential V; by virtue of the E1 excitation mode, E_x represents the difference of even-parity and odd-parity two-nucleon interactions, while V represents a sum of even and odd interactions. The effective mass for the model ground-state wave-function is treated as a derived quantity and turns out to be $M^*/M > \sim 1$; this large value is attributed to a Thomas shift associated with finite nuclear boundaries

609 COULOMB EXCITATION OF SECOND 2^+ STATES IN EVEN–EVEN MEDIUM WEIGHT NUCLEI.
P.H.Stelson and F.K.McGowan.
Phys. Rev. (USA), Vol. 121, No. 1, 209-24 (Jan. 1, 1961).

The location of a second 2^+ state was found for thirteen even–even medium-weight nuclei by means of Coulomb excitation produced by 8, 9, and 10 MeV α-particles. The relatively weak excitation of these states is detected by a coincident measurement of the cascade gamma rays. From the observed gamma-ray yields, information is obtained on the B(E2)'s for the crossover transitions. The crossover B(E2)'s exhibit some uniformity and are all rather weak, being about single-particle value or a little less. For some nuclei the cascades/crossovers ratio for the second 2^+ state is known from other work, and it is then possible to extract the B(E2) for the upper cascade transition. These upper cascade B(E2)'s exhibit enhancements comparable to those for the lower cascade transitions. Evidence is obtained for the "double E2" Coulomb excitation of the 4^+ state in Cd^{114} and this requires an enhanced $4 \to 2$ B(E2). In general, the measurements reported support a collective model interpretation, but it is as yet difficult to draw conclusions concerning the shape of the collective potential energy surface governing this motion.

610 POSSIBLE EXPLANATION OF THE ENERGY GAP IN THE EXCITATION SPECTRA OF NUCLEI. T.Sasakawa.
Progr. theor. Phys. (Japan), Vol. 22, No. 2, 311-12 (Aug., 1959).

A simple statistical argument, involving the effective mass and the pairing energy of nucleons, is used to predict first intrinsic excited states of even–even and odd mass nuclei which are consistent with experiment. E.A.Sanderson

NUCLEAR ORIENTATION IN COBALT METAL. See Abstr. 20786 of 1960.

611 NUCLEAR RESONANCE FLUORESCENCE IN Cu^{63}: LIFETIMES OF EXCITED STATES AND THE SLOWING DOWN OF RECOILS (3-100 eV) IN CONDENSED MEDIA.
J.B.Cumming, A.Schwarzschild, A.W.Sunyar and N.T.Porile.
Phys. Rev. (USA), Vol. 120, No. 6, 2128-37 (Dec. 15, 1960).

Measurements of the lifetimes of the 669 and 963 keV states of Cu^{63} were performed using the nuclear resonance fluorescence technique. Self-absorption experiments yielded mean lives $(2.94 \pm 0.24) \times 10^{-13}$ sec for the spin $\frac{1}{2}$ 669 keV level and $(7.2 \pm 1.8) \times 10^{-13}$ sec for the spin $\frac{5}{2}$ 963 keV level. The resonance yields from sources inside Cu metal and in water solution were measured. The reduction of the resonance yields due to slowing down of the recoils from the β^+ decay was calculated using the model of Vineyard et al. for the solid and with an elastic collision model for the liquid environments. These calculations are in good agreement with the measured yields and result in a unique spin assignment to the 669 keV state. The effect of the scatterer temperature on the resonance yield was shown to be in agreement with the "effective temperature" predicted by the theory of Lamb.

612 NOTE ON THE COLLECTIVE INTERPRETATION OF THE FIRST TWO 2+ LEVELS OF EVEN NUCLEI.
M.Jean.
Nuclear Phys. (Internat.), Vol. 21, No. 1, 142-56 (Nov. (4), 1960).
In French.

It is shown that the qualitative agreement with the experimentally observed ratio of electromagnetic de-excitation probabilities of the first 2+ levels of even nuclei which is exhibited by the theoretical predictions of the Davydov and Filippov asymmetric rotor model, can equally well be obtained for a more conventional model effecting a gradual transition between the quadrupole oscillations of spherical nuclei and the vibrations and rotations of spheroidal ones.

613 THE MEAN LIFE OF THE FIRST EXCITED STATE OF Al^{25}.
S.Gorodetzky, R.Richert, R.Manquenouille and A.Knipper.
C.R. Acad. Sci. (France), Vol. 251, No. 7, 944-6 (Aug. 17, 1960).
In French.

The mean life at 450 keV was measured by delayed γ–γ coincidence from the $Mg^{24}(p,\gamma)Al^{25}$ reaction. It was found to be $T_{\frac{1}{2}} = (1.88 \pm 0.10) \times 10^{-9}$ sec. A.E.I. Research Laboratory

614 LOWER LEVELS IN Ca^{43}.

T.Komoda.

Progr. theor. Phys. (Japan), Vol. 22, No. 6, 891-3 (Dec., 1959).

The lower levels of Ca^{43} as a function of a spin mixture parameter and a range parameter were calculated using configuration mixing. The energy values obtained for the first and second excited states and for the first excited state in Ca^{42} are listed and compared with the experimental values. In a suitable region of the range parameter the $J = \frac{5}{2}$ and the $J = \frac{7}{2}$ levels turn out to be very close, which is in accordance with experiment. F.Herbut

615 LEVEL STRUCTURE OF EU^{153}.

R.E.Sund and M.L.Wiedenbeck.

Phys. Rev. (USA), Vol. 120, No. 5, 1792-1802 (Dec. 1, 1960).

Gamma rays in Eu^{153} following the decay of Sm^{153} and Gd^{153} were studied using coincidence and angular correlation methods. Results for the strong transitions are in agreement with the decay scheme given by McCutchen (Abstr. 5276 of 1958). Measurements were made of spectra of gamma rays in coincidence with the X-ray, 70-keV, and the 97-keV and 103-keV transitions in the decay of Gd^{153}, and with eight energy regions in the decay of Sm^{153}. A number of new, weak transitions were observed in the decay of Sm^{153}, and a consistent decay scheme is proposed. Directional correlation measurements were made on the 70-103 keV cascade from the decay of Sm^{153} and from the decay of Gd^{153}. Possible spin assignments are discussed.

616 NUCLEAR ORIENTATION OF IODINE BY ELECTRIC H.F.S. ALIGNMENT.

C.E.Johnson, J.F.Schooley and D.A.Shirley.

Phys. Rev. (USA), Vol. 120, No. 5, 1777-80 (Dec. 1, 1960).

Nuclear alignment of iodine in a single crystal of copper p-iodobenzenesulphonate at a temperature of about 0.03° K was detected by measurement of the anisotropic angular distribution of gamma radiation from aligned I^{131}. No evidence was found for a nuclear spin—lattice relaxation time longer than a few seconds. The spin of the 637 keV level in Xe^{131} was established as $\frac{5}{2}$ and the E2/M1 mixing ratio of the 364 keV transition was found to be $\delta = -6.7 \pm 0.5$. The quadrupole coupling constant eQq/h was found to be -950 ± 190 Mc/s.

617 THE ENERGY LEVELS OF ^{24}Mg AND ^{32}S.

S.Hinds and R.Middleton.

Proc. Phys. Soc. (GB), Vol. 76, Pt 4, 553-8 (Oct. 1, 1960).

The energy levels of Mg^{24} and S^{32} were determined from studies of the $Na^{23}(He^3,d)Mg^{24}$ and the $P^{31}(He^3,d)S^{32}$ reactions. In both cases He^3 particles of up to 10.2 MeV were used and the deuteron energy spectra were measured with a broad-range magnetic spectrograph. Thirty-nine states were observed in Mg^{24} below an excitation energy of 11.861 MeV and twenty-four in S^{32} below 8.496 MeV.

618 PAIRING INTERACTION IN NUCLEI.

G.Abraham and K.K.Gupta.

Nuclear Phys. (Internat.), Vol. 19, No. 5, 496-9 (Nov. (6), 1960).

The first excited levels of O, Ca and Pb isotopes are calculated, using a constant pair interaction between particles outside the doubly closed shells. Quantitative agreement with experiment is obtained only for the Pb isotopes.

619 ENERGY LEVELS OF ^{29}P, ^{33}Cl AND ^{41}Sc FROM (d,n) REACTIONS.

B.E.F.Macefield and J.H.Towle.

Proc. Phys. Soc. (GB), Vol. 76, Pt 1, 56-64 (July, 1960).

The time-of-flight technique was used to study the neutron spectra from the reactions $Si^{28}(d,n)P^{29}$, $S^{32}(d,n)Cl^{33}$ and $Ca^{44}(d,n)Sc^{41}$. Weak neutron groups were resolved which corresponded to levels in P^{29} at 2.42 ± 0.04 and 3.13 ± 0.03 MeV, and in Cl^{33} at 2.11 ± 0.06 and 2.53 ± 0.06 MeV. Only one group could be definitely attributed to the $Ca40(d,n)Sc^{41}$ reaction, and this denotes at level Q-value of -2.86 ± 0.02 MeV.

620 ENERGY LEVELS OF Re^{187}.

R.G.Arns and M.L.Wiedenbeck.

Nuclear Phys. (Internat.), Vol. 19, No. 6, 634-53 (Dec. (2), 1960).

The gamma rays of Re^{187} following beta decay of the 24 hr W^{187} were studied using prompt and delayed coincidence techniques. A total of 25 gamma rays was found. Relative intensities are given for the gamma transitions. The directional correlation of the 552—134 keV cascade was measured. A decay scheme is proposed on the basis of the coincidence measurements. Spins and parities of the principal levels are discussed.

621 NUCLEAR ZEEMAN EFFECT IN Sn^{119}.

S.S.Hanna, L.Meyer-Schützmeister, R.S.Preston and D.H.Vincent.

Phys. Rev. (USA), Vol. 120, No. 6, 2211-13 (Dec. 15, 1960).

Ferromagnetic alloys of manganese and tin were used to obtain large internal magnetic fields at the tin nuclei. The resultant Zeeman splittings of the two low levels of Sn^{119} were measured by observing the hyperfine spectra in the resonant absorption of 24 keV radiation of Sn^{119}. In Mn_4Sn an internal field of roughly 40 kOe was found. In this field the splitting of the ground state was observed but that of the excited state was unresolved. In Mn_2Sn an internal field of about 190 kOe was produced. In this field additional structure was obtained which was attributed to the splitting of the excited state. The measured splitting gives a value of (0.78 ± 0.08) n.m. for the magnetic moment of the excited state.

622 NUCLEAR STRUCTURE OF $_{50}Sn^{120}$.

H.Ikegami.

Phys. Rev. (USA), Vol. 120, No. 6, 2185-96 (Dec. 15, 1960).

The radiations from 5.8 day Sb^{120m} were investigated in detail, using sector-type double-focusing magnetic spectrometers and scintillation counters. The following measurements were performed: coincident gamma-ray spectra, directional correlations of 1.18 MeV γ—1.03 MeV γ, 1.03 MeV γ—0.20 MeV γ, 1.18 MeV γ—0.20 MeV γ, 0.20 MeV γ—0.09 MeV γ, 0.20 MeV Ke^-—0.09 MeV γ and 0.20 MeV γ—0.09 MeV Ke^-. The 1.18 MeV γ—1.03 MeV γ polarization direction correlation, the conversion electron spectra and the mean lives of the 2.41 and 2.50 MeV levels were also investigated. The decay scheme of 5.8 day Sb^{120m} proposed by McGinnis (Abstr. 8285 of 1958) which gives the following assignments to the excited states in Sn^{120}, 1.18 MeV (2+), 2.21 MeV (4+), 2.41 MeV (6+), and 2.50 MeV (7−), is confirmed uniquely. These levels are interpreted as arising from the neutron configurations $(2d_{3/2})^2(1h_{11/2})^2$ and $(2d_{3/2})^3(1h_{11/2})^1$. The lifetimes of the 2.41, 1.18, andprobably 2.21 2.21 MeV levels are shorter by a factor 3-4 than those expected for single-proton transitions and may be explained by the neutron transition, assuming a somewhat larger effective charge of neutron in spherical nuclei. The high forbiddenness of the 0.09 MeV E1 + M2 transition is ascribable to the simultaneous j- and l-forbidden transition between the states involving $(2d_{3/2})^3(1h_{11/2})^1$ and $(2d_{3/2})^2(1h_{11/2})^2$ configurations. No appreciable effects of the nuclear finite size or any nuclear structure dependence on the internal conversion proces are detected even for highly forbidden 0.09 MeV E1 + M2 transition. In the decay of 16 min Sb^{120}, the 1.18 MeV gamma ray was detected. However, other gamma rays expected from the second level multiplet, which is a characteristic feature of the vibrational model, were not found.

623 NUCLEAR ORIENTATION OF Tb^{160}.

C.E.Johnson, J.F.Schooley and D.A.Shirley.

Phys. Rev. (USA), Vol. 120, No. 6, 2108-113 (Dec. 15, 1960).

Nuclear orientation of Tb^{160} in a single crystal of neodymium ethylsulphate was observed by the anisotropic intensity distribution of the γ-rays. The alignment arises from the coupling of the nuclear-magnetic and quadrupole moments with the crystal field. The spin of Tb^{160} is shown to be 3, and the spin of the 1360-keV level in Dy^{160} is 2. The nuclear moments of Tb^{160} are $\mu = 1.60 \pm 0.25$ n.m. and $Q = +1.9 \pm 0.5$ barns.

624 COULOMB EXCITATION OF STATES IN Th^{232} AND U^{238}.

F.K.McGowan and P.H.Stelson.

Phys. Rev. (USA), Vol. 120, No. 5, 1803-11 (Dec. 1, 1960).

The yields of gamma rays resulting from Coulomb excitation of states in Th^{232} and U^{238} with protons of 4 to 6 MeV energy were measured. Gamma rays of 790, 740, and 613 keV energy from Th^{232} and of 1.02 MeV energy from U^{238} were observed. For Th^{232}, the variation in gamma-ray yields with proton energy, the results from gamma-ray angular distributions, and the linear polarization measurements are consistent with the direct excitation of a 2+ state at 790 keV which decays by means of E2 radiation to the $I = 0^+$ and 2+ members of the ground-state rotational band. In view of recent results from internal conversion electron measurements (Abstr. 20398 of 1960) the 613 keV gamma ray is interpreted to be a transition from a 2+ β-vibrational state at 773 keV to the 4+ state at 163 keV. An interpretation of the observed gamma-ray yields is carried out taking a γ-vibrational state at 790 keV and a β-vibratio state at 773 keV. The $B(E2)_d$ of the 2+ state at 50 keV in Th^{232} is about 150 times the single-particle estimate. The $B(E2)_d$ of the vib tional states in Th^{232} and U^{238} are between 2 and 4 times the single-particle estimate. Combining Bernstein's relative internal conversion electron yields with the present gamma-ray data, a value of $(8 \pm 2) \times 10^{-2}$ for the strength parameter ρ is obtained for the E0 transition between the 2+ state at 773 keV and the 2+ state at 50 keV in Th^{232}

625

ENERGY LEVELS OF Zr^{90}.

V.K.Thankappan and Y.R.Waghmare.

Progr. theor. Phys. (Japan), Vol. 22, No. 3, 459-61 (Sept., 1959).

The energy separation of the low-lying levels of Zr^{90} is calculated. The low-lying levels are assumed to arise from the last two protons in the configurations $(p_{1/2})^2$, $J = 0$; $(g_{9/2})^2$, $J = 0,2,4,6,8$; and $(p_{1/2}, g_{9/2})$, $J = 4,5$. Harmonic oscillator wave-functions are used and a central two-body potential. The results are compared with the observed energy separations. L.L.Green

NUCLEAR DECAY RADIOACTIVITY

626

THE NECESSITY OF INTRODUCING A NEW RADIO-BIOLOGICAL QUANTITY.

R.Grigorovici and M.Oncescu.

Stud. Cercetari Fiz. (Roumania), Vol. 9, No. 4, 483-8 (1958). In Roumanian.

It is inconvenient to use the absorbed dose as a measure of biological effects due to radiation, since this quantity is not additive. In studying the systems of units used in other fields of biophysics, the authors have been led to establish a coherent system, of "radiobiological" units, for use with all kinds of radiations. The introduction of a biophysical quantity — the biological dose — is proposed. which is defined in terms of the absorbed dose and the relative biological effectiveness. The unit of the biological dose is the rem, while the unit of the absorbed dose is the rad.

627

DETERMINATION OF THE SPECIFIC ACTIVITY OF A FLUID FROM THE DOSE-RATE MEASURED AT THE SURFACE OF CYLINDRICAL CONTAINERS OR PIPES.

W.Kattwinkel.

Atomkernenergie (Germany), Vol. 4, No. 11, 446-9 (Nov., 1959). In German.

The specific γ-activity can be evaluated from the dose rate at the surface of cylindrical containers or pipes if the connection between the specific activity and dose rate is known under given conditions. The connection is generally derived by means of the "buildup" concept. The case of $N^{16}(E_0 = 6.2$ MeV$)$ in water is treated in detail.

628

THE DEPOSITION OF RADIOACTIVE ATOMS ON AEROSOLS.

L.Lassen and G.Rau.

Z. Phys. (Germany), Vol. 160, No. 5, 504-19 (1960). In German.

The attachment of the decay products of thorium emanation to aerosol particles was studied. The dependence of the attached activity on the particle size was determined for spherical particles with radii R ranging from 0.04 to 0.6μ. The particles used were homogeneous dioctylphthalate droplets and polystyrene micro-spheres. It is found that the attached activity is proportional to $R^2/(1 + hR)$. This dependence can be derived theoretically by considering the deposition to be solely governed by the diffusion process (not by electrostatic forces) and assuming a quasi-stationary density distribution for the diffusing atoms. The constant h is uniquely determined by the average gas on kinetic velocity and the diffusion constant of the diffusing atoms. For the decay products of thorium and radium emanation (atomic weight $\cong 210$) $h \cong 7 \times 10^4\ cm^{-1}$. The derived equation holds for a wide range of particle sizes. For particles with radii larger than $\sim 10^{-4}$, this means that the attachment is proportional to the radius; for particle radii below about 10^{-6} cm it is proportional to the surface (R^2) of the particles. It is also possible to derive an expression for the time dependence of the attachment process from theoretical considerations. The rate at which the average concentration of the radioactive atoms decreases is proportional to $\exp(-t/\tau)$, where

$$\tau = \frac{1 + hR}{\pi R^2 N \nu}$$

(ν = average gas kinetic velocity of the diffusing atoms; N = aerosol concentration).

629

SOME METHODS IN THE PREPARATION OF RADIOACTIVE MATERIALS FOR USE IN BETA-SPECTROSCOPY.

W.Parke, M.De Croës and K.Sevier, Jr.

Nuclear Instrum. and Methods (Internat.), Vol. 7, No. 1, 22-36 (April, 1960).

The initial results of an investigation dealing with the most appropriate methods for the preparation of radioactive materials for use in beta-spectroscopy are reported. A short review of the methods and techniques developed for this type of preparation is presented, and, where possible, improvements are suggested. The investigation has been carried out in four main parts, namely, thin film preparation and thickness determination, electro- and vacuum deposition, and miscellaneous techniques, and is reported in the same order. In conclusion, tables designating the deposition efficiencies obtained from the preparation of 45 different radioactivee materials by employment of the various methods are given.

630

THIN FILM THICKNESS DISTRIBUTION BY ALPHA ABSORPTION.

M.De Croës, W.Parker and K.Sevier, Jr.

Nuclear Instrum. and Methods (Internat.), Vol. 7, No. 2, 160-6 (May, 1960).

An instrument for the determination of thin film thickness distribution is described. Thickness distribution curves for films of organic compounds, metals, and aluminium oxide which are used primarily for counter windows and in connection with radio-active source preparation are presented. The principle employed, where the "gas-equivalent" of the film or foil of material is measured, provides results to a good degree of accuracy.

PREPARATION OF DEFECTS IN SOLIDS BY RADIOACTIVE DECAY: SOLID TRITIUM AND Kr^{85}. See Abstr. 20855 of 1960.

631

DECAY OF Ag^{104} AND LEVELS IN Pd^{104}.

H.Nutley and J.B.Gerhart.

Phys. Rev. (USA), Vol. 120, No. 5, 1815-18 (Dec. 1, 1960).

The radioactive decay of the isomers of Ag^{104} was investigated using scintillation spectrometers and a magnetic beta-ray spectrometer. Half-lives of 66 ± 1 and 29.8 ± 0.5 min were determined for the spin 5 and spin 2 isomers, respectively. Conversion electrons corresponding to 15 gamma-rays assigned to Pd^{104} were observed. Two allowed positron transitions were detected: one of end-point energy 990 ± 10 keV from the spin 5 isomer of Ag^{104}; and the other of end-point energy (2705 ± 15) keV from the spin 2 isomer. Gamma—gamma and beta—gamma concidences were observed. The experimental data together with data obtained by other investigators is used to determine the spins and parities of the low-lying excited states of Pd^{104}.

632

A NEW ISOMERIC STATE OF Cs^{131}.

E.Bodenstedt, H.J.Körner, C.Günter, D.Hovestadt and J.Radeloff.

Nuclear Phys. (Internat.), Vol. 20, No. 4, 557-60 (Nov. (3), 1960).

A new isomeric state at 133 keV was found. The half-life was determined as $T_{1/2} = 13.3 \pm 0.5$ nsec. The level is interpreted as the $g_{7/2}$ shell model state. A new determination of the half-life of the 124 keV level gave $T_{1/2} = 3.77 \pm 0.05$ nsec.

RADIATIONS FROM 5.8 DAY Sb^{120m}. See Abstr. 622 .

633

ELECTROMAGNETIC TRANSITIONS IN ISOMERIC NUCLEI.

L.I.Rusinov and D.A.Varshalovich.

Atomnaya Energiya (USSR), Vol. 5, 432 (1958). In Russian. English translation in: Reactor Science (GB), Vol. 10, No. 3-4, 170-81 (Sept., 1959).

The γ-ray transition probability of isomeric nuclei is compared with theoretical estimates. The comparison is made for allowed and for j and l-forbidden transitions in spherical nuclei as well as for transitions between levels of the same rotation band and for single particle and K-forbidden transitions in deformed nuclei. The experimental data on electromagnetic radiation and on the quantum characteristics of isomeric nuclei agree with presentday ideas on the structure of the nucleus.

634

HALF-LIVES OF At^{211} AND Bi^{207}.

E.H.Appelman.

Phys. Rev. (USA), Vol. 121, No. 1, 253-5 (Jan. 1, 1961).

Least-squares analysis of alpha counting data yielded a half-life of 7.214 ± 0.007 hr for At^{211} in good agreement with previous results. From the gamma activity remaining after the decay of an extremely active At^{211} preparation, the half-life of Bi^{207} was found to be 38 ± 3 yr. This agrees with the highest of the values hitherto reported.

635 RADIATIVE TRANSITIONS IN ^{8}Be.

I.S.Grant.

Proc. Phys. Soc. (GB), Vol. 76, Pt 5, 737-44 (Nov., 1960).

A measurement was made of the angular correlation between the 14.7 MeV γ-radiation from the reaction $Li^7(p,\gamma)$ and the α-particles from the break-up of the 2.9 MeV excited state of Be^8. The electric quadrupole to magnetic dipole amplitude ratio δ could be derived from the angular correlation. Under the assumption that the resonant component of the γ-radiation has an isotropic angular distribution, δ was found to be 0.21 ± 0.07. The predictions of the independent-particle model, using a central force fitted to the properties of neighbouring nuclei, were in good agreement with the observed ratio δ and with the widths of both the 17.6 MeV and the 14.7 MeV transitions when the intermediate coupling parameter a/K was about 2.

636 ELECTRON POLARIZATION IN ALLOWED BETA-TRANSITIONS WITH COULOMB CORRECTIONS.

G.Felsner and M.E.Rose.

Z. Phys. (Germany), Vol. 159, No. 5, 505-15 (1960).

Investigates the occurrence of complete polarization. Concludes that where the electrons are produced in one spin state only, this is a consequence of angular momentum conservation. R.J.N.Phillips

637 NEW NUCLEIDE ACTINIUM-231.

K.Takahashi and H.Morinaga.

Nuclear Phys. (Internat.), Vol. 21, No. 1, 133-6 (Nov. (4), 1960).

A new nuclide actinium-231 was indentified from the reaction of $Th^{232}(\gamma, p)Ac^{231}$ induced by 25-MeV bremsstrahlung. The activity was chemically separated from fission products with the aid of a recoil method. The half-life of this new isotope was found to be $T_{\frac{1}{2}}$ = 15 ± 1 min and the end-point energy of the beta ray was E_β = 2.1 ± 0.1 MeV. Several weak gamma rays were also observed.

638 CONTRIBUTIONS TO THE DECAY OF Eu^{152}.

W.Schneider.

Nuclear Phys. (Internat.), Vol. 21, No. 1, 55-65 (Nov. (4), 1960).

The spectrum of the β^--particles emitted in the decay of 13 y Eu^{152} has been studied with a magnetic spectrometer of the Zünti type and with a semicircular spectrometer of high resolution. The shape factor proposed by Langer et al. for the 1490 keV β^--spectrum was confirmed and the relative intensities of the other β^--transitions were redetermined. Only the intensity of the 1070 keV β^--transition is strongly influenced by the choice of the correction factor applied to the spectrum of the 1490 keV β^--transition. The energies and intensities of internal conversion lines obtained in this experiment are in good agreement with those previously reported. The spin-parity assignment for the highest excited level in Gd^{152} is proposed to be 2−.

639 COMPARISON OF THE β—α ANGULAR CORRELATIONS IN Li^8 AND B^8.

M.E.Nordberg, F.B.Morinigo and C.A.Barnes.

Phys. Rev. Letters (USA), Vol. 15, No. 7, 321-3 (Oct. 1, 1960).

Reports an improved measurement of the β—α angular correlations in the β-decay of Li^8 and B^8 by a method previously described (Abstr. 5692 of 1960). In laboratory coordinates, taking account of the recoil of the Be^{8*}, the angular correlation is of the form $W(\theta) = 1 + A\cos\theta + B\cos^2\theta$. Measurement of the difference of the B coefficients for the two decays provides a means of testing the conserved vector current theory of β-decay. Calculations by Weidenmüller (Abstr. 9581 of 1960) on an intermediate coupling model predict $0.005\ W_\beta \le \delta \le 0.009\ W_\beta$ based on the above theory and $0.001\ W_\beta \le \delta \le 0.004\ W_\beta$ on the Fermi theory. The results of these measurements give $B(Li^8) = (0.0029 \pm 0.0003)W_\beta$, $B(B^8) = -(0.004 \pm 0.0007)W_\beta$ and $\delta = (0.0069 \pm 0.0008)W_\beta$. This is in good agreement with the conserved vector current theory. R.E.Meads

640 THE DECAY OF Pm^{149}.

A.Artna and M.E.Law.

Canad. J. Phys., Vol. 38, No. 12, 1577-85 (Dec., 1960).

The 52.8-hour activity of Pm^{149} has been investigated using a high resolution beta spectrometer, a lens type coincidence spectrometer, and a scintillation spectrometer in conjunction with a multichannel analyser. The beta spectrum was found to consist of two groups with maximum energies of 1.072 ± 0.002 MeV and 0.786 ± 0.004 Mev, and intensities of 97.1 ± 0.4% and 2.9 ± 0.4% respectively. A gamma-ray of energy 285.7 ± 0.3 keV was found to be in coincidence with the 0.786-MeV beta group. No other gamma-rays with intensities greater than 0.1% were found. The K conversion coefficient for the 286 keV transition was measured to be 0.075 ± 0.008. This together with the values of 6.5 ± 0.7 and 4 ± 1 obtained for the K/L and L/M conversion ratios respectively indicate that this transition is M1 in character with less than 10% E2 admixture.

641 LONGITUDINAL POLARISATION OF BETA PARTICLES FROM Rb^{86}, Pr^{144} AND Co^{60}.

M.C.Joshi, V.G.Kulkarni, C.V.Panat and B.V.Thosar.

Proc. Indian Acad, Sci. A, Vol. 49, No. 6, 322-5 (June, 1959).

An experimental set up is described for converting longitudinal polarisation of beta particles to transverse polarisation and for determining the degree of polarisation, using the method of Mott scattering from a thin gold foil. Electron polarisation in the energy range 90 to 150 keV can be studied. The degree of polarisation for beta particles of energy 110 keV from Co^{60}, Pr^{144} and Rb^{86} has been determined and is seen to be equal to -V/C, within the limits of experimental error.

642 β-SPECTRUM AND HALF-LIFE OF Rb^{87}.

K.Egelkraut and H.Leutz.

Z. Phys. (Germany), Vol. 161, No. 1, 13-19 (1960). In German.

The β-decay was studied with a scintillation spectrometer. To avoid source absorption and scattering troubles, RbI:Tl and NaI:Tl + RbI or CsI:Tl + RbI crystals were used. The β-spectrum was measured down to 6 keV and the observed maximum β-energy was found to be 275 ± 5 keV. The specific activity of natural Rb was determined to be 740 ± 10 curies per sec per gram and the half-life of Rb^{87} to be $(5.82 \pm 0.1) \times 10^{10}$ years.

643 THE ELECTRON SPECTRUM OF $_{81}Tl^{199}$.

B.Jung and J.Svedberg.

Nuclear Phys. (Internat.), Vol. 20, No. 4, 630-47 (Nov. (3), 1960).

The electron spectrum between 5.75 and 950 keV of mass-separated Tl^{199} sources was studied in a double focusing β-spectrometer, adjusted to a momentum resolution of about 0.4%. The experimental findings are in accordance with the following level sequence in Hg^{199}: ground state $(\frac{1}{2}-)$, 158.4 $(\frac{5}{2}-)$, 208.2 $(\frac{3}{2}-)$, 403.4 $(\frac{1}{2}-)$, 455.4 $(\frac{1}{2}-)$ and 492.2 keV $(\frac{3}{2}-)$. The half-life of Tl^{199} was measured as 7.42 ± 0.08 hr. The K- and L- Auger spectra of mercury are briefly discussed.

644 LOSS OF ACTIVITY FROM BETATRON IRRADIATED SAMPLES BY DIFFUSION.

H.Fuchs and K.H.Lindenberger.

Nuclear Instrum. and Methods (Internat.), Vol. 7, No. 2, 219-20 (May, 1960).

Experiments were performed to establish relative integrated cross-sections for photonuclear reactions leading to positron emitters. The ratios of the residual activities were measured by counting the number of annihilation quanta with a NaI spectrometer. As a check of the reproducibility of this technique, samples of different thicknesses containing carbon from different materials together with a 2 mm thick graphite sample used as a monitor were irradiated with 34 MeV bremsstrahlung. The C^{11} activities resulting from the process $C^{12}(\gamma, n)$ were compared, also the half-life was established in each case. The results are summarized in a table.

645 ft VALUE OF O^{14} AND THE UNIVERSAL FERMI INTERACTION.

R.K.Bardin, C.A.Barnes, W.A.Fowler and P.A.Seeger.

Phys. Rev. Letters (USA), Vol. 5, No. 7, 323-6 (Oct. 1, 1960).

Measurements of the Q values of the reactions

$$C^{12} + He^3 \rightarrow O^{14} + n^1 + Q_n$$

and

$$C^{12} + He^3 \rightarrow N^{14*} + H^1 + Q_p$$

yield an estimate of the maximum energy of the positrons in the $0^+ \rightarrow 0^+$ decay of O^{14}:

$$E_{max}(\beta^+) = Q_p - Q_n + (H^1 - n^1)c^2 - 2m_ec^2$$

$$= Q_p - Q_n - (1804.6 \pm 0.5)\ \text{keV}$$

The threshold for the first reaction was determined by studying the delayed yield of γ-rays from the O^{14} β^+ decay, the He^3 energy being determined by an electrostatic analyser. In the second reaction, he energy of the outgoing protons was measured by a magnetic spectrometer. The results gave $Q_n = -1148.3 \pm 0.7$ keV and $Q_p = 2466 \pm 1.1$ keV, whence $E_{max}(\beta^+) = 1810.6 \pm 1.5$ keV. A new value of 71.1 ± 0.2 sec for the half-life of O^{14} was obtained and this, together with the above value of $E_{max}(\beta^+)$ yields after correction an ft value 3069 ± 13 sec. This result was used to calculate a value of G_ν, the coupling coefficient in vector nuclear decay, and gives the result $G_\nu = (1.416 \pm 0.003) \times 10^{-49}$ erg cm³. In deciding the validity of the idea that all weak interactions proceed by a universal Fermi interaction it is of interest to know how nearly G_ν equals G_μ, the coupling constant in muon decay. If the above value of G_ν is equated to G_μ a value is calculated for the muon mean lifetime which is 1.8% greater than the observed value of 2.210 ± 0.003 μsec.

R.E.Meads

646 THE DECAY CHAIN $Yb^{164} \rightarrow Tm^{164} \rightarrow Er^{164}$.

A.Abdurazakov, K.Gromov, B.Dalkhsuren, B.Dželepov, I.Levenberg, A.Murin, Yu.Norseyev, V.Pokrovsky, V.Chumin and I.Yutlandov.

Nuclear Phys. (Internat.), Vol. 21, No. 1, 164-9 (Nov. (4), 1960).

It has been established that among the spallation products of Ta there is an isotope Yb^{164}($T_{\frac{1}{2}}$ = 75 ± 2 min) which disintegrates into a hitherto unknown isotope Tm^{164} ($T_{\frac{1}{2}}$ = 2 ± 0.5 min). Tm^{164} turns into stable Er^{164} emitting positrons with an end-point energy of 2940 ± ± 20 keV, and γ-rays of 91.5 ± 0.1 keV and 211 ± 2 keV.

647 L/K-CAPTURE RATIO AND E_L/E_K FOR Ar^{37}.

A.G.Santos-Ocampo and D.C.Conway.

Phys. Rev. (USA), Vol. 120, No. 6, 2196-2200 (Dec. 15, 1960).

The L/K capture ratio of A^{37} was determined to be 0.103 ± 0.003 in a high-pressure, multiwire proportional counter. This value is in excellent agreement with the theoretical value of 0.100. The average energy of the L-peak was found to be 273 ± 6eV. When a new value of 265 ± 5 eV is obtained for the critical L-absorption energy of Cl by interpolation and the effect of the Auger process is considered, it is concluded that the energy to produce an ionpair in A at 0.2 keV is 0.98 ± 0.04 times the value at 2.8 keV.

648 GAMMA RAYS FROM Ga^{65} DECAY AND HALF-LIFE OF THE 54 keV LEVEL OF Zn^{65}.

L.S.August and J.F.Friichtenicht.

Phys. Rev. (USA), Vol. 120, No. 6, 2072-80 (Dec. 15, 1960).

The energies and intensities of the gamma rays following the positron and electron capture decay of Ga^{65} were determined by means of scintillation spectrometry techniques. At least twenty gamma-rays de-excite proposed levels in Zn^{65} at the following energies (in keV): 53.95 ± 0.01, 115.13 ± 0.02, 206 ± 2, 773 ± 10(?), 863 ± 10, 1040 ± 15, 1310 ± 20, 1480 ± 20, 1970 ± 40, and ~2300. A consistent cascade scheme for Zn^{65} is presented which incorporates all of the observed gamma transitions. The first excited state of Zn^{65} was found to be isomeric with a half-life of 1.65 ± ± 0.05 μsec.

649 RADIOACTIVE DECAY OF Lu^{171} AND LEVEL SCHEMES FOR Yb^{171} AND Yb^{169}. R.G.Wilson and M.L.Pool.

Phys. Rev. (USA), Vol. 120, No. 5, 1843-50 (Dec. 1, 1960).

Ytterbium oxide enriched to 93.8% in the mass number 171 was irradiated with 6 MeV protons. An activity decaying by electron capture with a half-life of 8.28 ± 0.04 days was produced and its assignment to Lu^{171} confirmed by the identification of the ytterbium K X-ray and by comparison with the activities produced by similar proton irradiations of each of the other enriched isotopes of ytterbium. The radiations observed in this activity were the L and K X-rays of ytterbium and gamma rays with energies of 72 – 76, 668 ± 7, 740 ± 3, and 841 ± 8 keV. Because neither particle nor annihilation radiation exists in this activity, the mode of decay is solely by electron capture to Yb^{171}. Gamma–gamma coincidence measurements were performed for the observed radiations. An energy level scheme was constructed for the decay of Lu^{171} using the results of the gamma–gamma coincidence measurements, an energy analysis of the conversion electron data, and calculations of transitions intensities for various trial multipole orders. Levels in Yb^{171} at 0 ($\frac{1}{2}-$ [521]), 66.7 ($\frac{3}{2}-\ \frac{1}{2}$), 75.9 ($\frac{5}{2}-\ \frac{1}{2}$), 95.1 ($\frac{7}{2}+$ [633] $\tau >$ $> 10^{-5}$ sec), 122.4 ($\frac{5}{2}-$ [512]), 167.3 ($\frac{9}{2}+\ \frac{7}{2}$), 208.1 ($\frac{7}{2}-\ \frac{5}{2}$), 230.5 ($\frac{7}{2}-\ \frac{1}{2}$), 246.5 ($\frac{9}{2}-\ \frac{1}{2}$), 317.3 ($\frac{9}{2}-\ \frac{5}{2}$), (350), 835 ($\frac{7}{2}-$ [514]), 862 (possibly $\frac{5}{2}+$ [642]), 935 ($\frac{9}{2}+$ [624]), and 949 ($\frac{7}{2}$) keV account for 30 of 31 transitions reported for this activity. Transition probabilities and branching ratios for the electron capture decay have been calculated. 84% of the disintegrations of the $\frac{7}{2}+$ [404] ground state of Lu^{171} occur to the $\frac{7}{2}-$ [514] state at 835 keV in Yb^{171}. The previously reported 600-day activity of Lu^{171} (Abstr. 4650 of 1951) was not found. An energy level scheme for the decay of Lu^{169} (1.5 days) as reported by other workers is proposed with levels in Yb^{169} at 0 ($\frac{7}{2}+$ [633]), 24.2 ($\frac{1}{2}-$ [521]), 70.9 ($\frac{9}{2}+\ \frac{7}{2}$), 87.0 ($\frac{3}{2}-\ \frac{1}{2}$), 99.3 ($\frac{5}{2}-\ \frac{1}{2}$), 161.7 ($\frac{11}{2}+\ \frac{7}{2}$), 191.4 ($\frac{5}{2}-$ [512]), 244.0 ($\frac{7}{2}-\ \frac{1}{2}$), 264.5 ($\frac{9}{2}-\ \frac{1}{2}$), 278.7 ($\frac{7}{2}-\ \frac{5}{2}$), 389.7 ($\frac{9}{2}-\ \frac{5}{2}$), 523.1 ($\frac{11}{2}-\ \frac{5}{2}$), 570.5 ($\frac{5}{2}+$ [642]), 648.2 ($\frac{7}{2}-$ [514]), 962.2, 1451.6 ($\frac{9}{2}+$ [624]), 1456 ($\frac{9}{2}$), and 1465 ($\frac{9}{2}$) keV and with less certainty, at 488.9 ($\frac{11}{2}-\ \frac{1}{2}$), 798, 870, 953, and 973 keV. This scheme accounts for 53 observed transitions following the decay of Lu^{169}. The ground state of Lu^{169} is probably the $\frac{9}{2}$ [514] orbital also assigned to the ground state of Lu^{173}. This scheme is based upon an energy analysis of the reported transitions, intensity calculations for various trial multipole orders, and analogy with the scheme proposed for Yb^{171}.

650 RADIOACTIVE DECAY OF Pm^{143}, Pm^{144}, AND Pm^{146}.

E.G.Funk, Jr, J.W.Mihelich and C.F.Schwerdtfeger.

Phys. Rev. (USA), Vol. 120, No. 5, 1781-9 (Dec. 1, 1960).

The decays were studied with permanent magnet spectrographs, and intermediate-image beta spectrometer, and scintillation counters. Results on the electron-capture decay of Pm^{142} and Pm^{144} confirm the findings of previous investigators. The results of gamma–gamma directional correlation measurements are consistent with the spin assignments for the Nd^{144} levels made by Ofer (Abstr. 6075 of 1959). Pm^{146} ($T_{1/2}$ ~ 710 days) is found to decay both by beta emission to a level of 749 keV in Sm^{146} and by electron capture to levels of 453 and 1198 keV in Nd^{146}. The percentage branchings are 35, 35, and 30%, respectively. Gamma-ray transitions of 453 and 745 keV in cascade in Nd^{146} and 749 keV in Sm^{146} are observed. The end-point energy for the beta-decay branch is measured to be 779 keV. Directional correlation and internal conversion coefficient measurements are most consistent with a 3+ assignment for the 1198 keV level in Nd^{136}, with a 2+ assignment being possible, but less likely, since the cross-over transition is absent or extremely weak.

651 ON THE DETERMINATION OF THE ELECTRON-CAPTURE DECAY ENERGIES OF Tl^{201} AND Tl^{202}.

R.K.Gupta.

Ark. Fys. (Sweden), Vol. 17, Paper 18, 337-42 (1960).

The decay energy of Tl^{201} has been calculated by deducing the ratio between the probabilities of L_I and K-electron capture to the 167 keV state in Hg^{201} from the number of coincidences between the 167 keV gamma-ray and the K X-rays. The value of the total decay energy was found to be 405 $^{+70}_{-40}$ keV. In a similar way the total decay energy of Tl^{202}, calculated from the number of coincidences between the 965 keV gamma-ray and the K X-rays, was found to be 1110 ± 20 keV.

652 RADIOACTIVE DECAY OF Tm^{164} AND Tm^{162}.

R.G.Wilson and M.L.Pool.

Phys. Rev. (USA), Vol. 120, No. 5, 1827-9 (Dec. 1, 1960).

Erbium oxide enriched to 35.1 and 14.1% in the mass numbers 164 and 162, respectively, were irradiated with 6 MeV protons. Activities decaying by electron capture with half-lives of 2.04 ± 0.10 and 77 ± 4 min were produced and are assigned to Tm^{164} and Tm^{162}, respectively, by the identification of the erbium K X-ray, comparison with the activities produced by similar proton irradiations of each of the other enriched isotopes of erbium, and by the existence in the 2.04 min activity of a prominent gamma-ray with the energy of the first excited level in Er^{164} determined from the decay of Ho^{164}. The gamma-ray spectrum of Tm^{164} consists of only the erbium K X-ray, a gamma-ray of 91 keV, and annihilation radiation; and that of Tm^{162}, of the erbium K X-ray and gamma-rays of 102 and 236 keV. The three radiations observed in the decay of Tm^{162} are all in coincidence. Energy level schemes for the decay of these two new activities are proposed and branching ratios are estimated from relative intensities.

653 GAMMA-RADIATION FOLLOWING RESONANT PROTON CAPTURE BY CHLORINE.

J.C.Lisle and P.F.D.Shaw.

Proc. Phys. Soc. (GB), Vol. 76, Pt. 6, 929-38 (Dec. 1, 1960).

Eleven resonances were observed in the yield of gamma-radiation produced by the bombarding of chlorine with protons of energies between 500 and 1000 keV. These were assigned to their parent isotopes either by the use of isotopically enriched targets or from the gamma-rays emitted. The decay schemes of six capture states of A^{36} were studied in detail and interpreted in terms of bound states at 1.97, 4.17, 4.45, 4.94, 5.85 and 6.85 MeV. Angular distribution measurements confirmed that the spin of the 4.17 MeV level is 3; from the modes of decay, tentative spin and parity values were assigned to some of the other levels.

654 THE DECAY OF Ir^{194}.
J.Kern and G.Bäckström.

Nuclear Phys. (Internat.), Vol. 19, No. 5, (Nov. (6), 1960).

The decay of Ir^{194} was investigated by means of a double focusing spectrometer, mostly by the photo-electron technique. A total of 32 transitions was observed, and their energies and intensities have been measured. An internally converted transition of 1480 keV, for which no gamma ray could be detected, showed that a 0+ state of this energy is populated. The log ft values for the beta branches showed that all the 18 levels excited are of even parity. By comparison of the measured gamma intensities with the conversion intensities of corresponding transitions in the decay of Au^{194}, spin values could be assigned for many levels. Evidence for a new 0+ state at 1547 keV was obtained in this manner. Indications were found for E0 admixture in competition with M1 and E2 multipolarities. A state at 923 keV may be interpreted as the 3+ level in the asymmetric rotor theory.

655 GAMMA TRANSITIONS FOLLOWING THE DECAY OF NICKEL-65.
R.Jambunathan, M.R.Gunye and B.Saraf.

Phys. Rev. (USA), Vol. 120, No. 5, 1839-42 (Dec. 1, 1960).

The gamma transitions following the decay of 2.6 hr Ni^{65} were studied by coincidence scintillation spectrometry. Gamma rays of energies 0.37, 0.51, 0.61, 0.77, 0.85, 0.95, 1.11, 1.48, 1.62, and 1.72 MeV having intensities of 55, 1.5, 0.6, ~ 1, ~ 0.6, ~ 0.3, 140, 290, 10, and 6 per thousand disintegrations, respectively, are emitted in this decay. The gamma–gamma coincidence study is consistent with energy levels of Cu^{65} at 0.77, 1.11, 1.48, 1.62, and 1.72 MeV. The angular correlation of 0.37 and 1.11 MeV gamma-rays suggests the spin assignment of $\frac{5}{2}$ for the 1.11 MeV level and $\frac{7}{2}$ or $\frac{3}{2}$ for the 1.48 MeV level. Both the gamma transitions are mixtures of E2 and M1.

656 DECAY OF Eu^{155}
K.S.Y.Ambiye, M.C.Joshi and B.V.Thosar.

Proc. Indian Acad. Sci. A, Vol. 50, No. 5, 342-8 (Nov., 1959).

Measurements were made on the β-rays and on K and L conversion electrons from γ-rays in coincidence with the β-rays. The results and proposed level scheme are discussed and compared with previous measurements. L.L.Green

657 CONVERSION LINE SPECTRUM OF Po^{214} (RaC′).
G.Lührs and C.Mayer-Böricke.

Z. Naturforsch. (Germany), Vol. 15a, No. 11, 939-49 (Nov., 1960). In German.

This was measured with a double-focusing β-spectrometer in the region from 2600 to 13 500 gauss cm (Rn^{222} source). The energy and absolute intensity of about 60 conversion lines — among these a number of hitherto unknown lines — were determined. In about 20 cases the absolute conversion coefficients of γ-transitions were determined and compared with the tables of Sliv and Band (1958) and/or Rose to find the multipolarities. In some cases, the K/L ratios could also be measured and the results agree well with the conclusions drawn from the interpretation of the absolute conversion coefficients. A tentative decay scheme for the decay Bi^{214}–Po^{214} was established using the information about the conversion lines and all other known data concerning this decay. The end-point energy of the RaC β-spectrum was found to be (3275 ± 15) keV.

658 THE DECAY OF Tl^{201}.
C.J.Herrlander, R.Stockendal and R.K.Gupta.

Ark. Fys. (Sweden), Vol. 17, Paper 17, 315-35 (1960).

Using beta- and gamma-spectroscopic techniques, the decay of Tl^{201} was investigated. The half-life of Tl^{201} was remeasured to be (73.5 ± 0.8) h. From internal conversion measurements in a double-focusing beta spectrometer, the energies of the four transitions previously known were found to be 30.60, 32.19, 135.34 and 167.43 keV. In addition, conversion lines of a new, weak transition of energy 165.88 keV were detected. From the measured conversion ratios the multipolarities of all the transitions were proved to be M1, although, for the 165.88 keV transition, an E2 admixture of up to 7% cannot be excluded. A further proof of the multipolarity assignments of the 135.34 and 167.43 keV transitions was obtained from a determination of absolute internal conversion coefficients using the method of external conversion. Electron–gamma and gamma–gamma coincidence measurements were performed. The collected experimental information is in agreement with the following level sequence: 3/2 - (0 keV), 5/2 -(1.57 keV), 3/2- (32.19 keV), and 3/2 - (167.49 keV); or 3/2 - (0 keV), 1/2 - (1.57 keV), 1/2 - or 3/2 (32.19 keV), and 1/2 - or 3/2 - (167.49 keV). Electron-capture branching ratios are given. The investigation also gives information about relative intensities of the KLL Auger lines in mercury, and relative photo cross-sections for L subshells of uranium, $(\tau_{L_I} + \tau_{L_{II}})/\tau_{L_{III}}$. The experimental results are in both cases compared with theoretical calculations.

659 BETA–GAMMA DIRECTIONAL CORRELATION IN Rb^{86} AND Eu^{152}.
H.J.Fischbeck and R.G.Wilkinson.

Phys. Rev. (USA), Vol. 120, No. 5, 1762-7 (Dec. 1, 1960).

The energy dependence of the beta–gamma angular correlation coefficient was measured in the special first-forbidden cases of Rb^{86} and Eu^{152}. Energy selection of the beta rays was accomplished with a magnetic beta-ray spectrometer having good transmission. It is shown that Rb^{86} cannot be analysed in terms of the so-called modified B_{ij} approximation. The Eu^{152} decay, on the other hand, can be treated quite satisfactorily in this approximation. It is concluded in this case that a strong selection-rule effect is operative to suppress certain of the matrix elements relative to B_{ij}. The nuclear parameter Y (Kotani's notation) is found to be 0.69 ± 0.06. This agrees well with the value which results from the measured spectrum shape factor.

660 ISOTOPIC SPIN CONSERVATION AND BETA–GAMMA CIRCULAR POLARIZATION CORRELATION IN A^{41} AND Sc^{46}.
S.D.Broom, L.G.Mann and J.A.Miskel.

Phys. Rev. Letters (USA), Vol. 5, No. 7, 326-9 (Oct. 1, 1960).

Measurements of the beta–gamma circular polarization correlation for A^{41} and Sc^{41} may be used to identify the presence of a Fermi component in the beta decay leading to violation of isotopic spin conservation. This paper describes measurements of the relative asymmetry for A^{41} and Sc^{41} using Na^{22} and Co^{60} sources to obtain absolute values of the matrix elements. The results indicate small values for the Fermi matrix elements in both cases and are compatible with isotopic spin conservation. These results are in conflict with earlier measurements. R.H.Thoma

661 EXCEPTIONS TO GAMMA INTENSITY RULES IN NUCLEAR ROTATIONAL SPECTRA.
K.Helmers.

Nuclear Phys. (Internat.), Vol. 20, No. 4, 585-9 (Nov. (3), 1960).

The usual gamma intensity rules in nuclear rotational spectra can be proved only for transition operators that do not depend on collective angular momentum. It is shown that in the Bohr–Mottelson nuclear model only the magnetic dipole and magnetic octupole operators do not satisfy this condition and thus may give rise to unusual branching ratios.

662 THE DECAY OF As^{76} TO Se^{76}.
G.Bäckström and I.Marklund.

Ark. Fys. (Sweden), Vol. 17, Paper 22, 393-409 (1960).

The gamma-rays were investigated by means of a double focusing spectrometer and a scintillation apparatus. Transitions of the following energies (keV) and relative intensities were found: 559.28 ± 0.10(100), 657.36 ± 0.15(14.1), 767.9 ± 2(0.17), 869.1 ± 2(0.24), 1216.0 ± 0.4(9.7), 1228.7 ± 0.5(2.3), 1438.3 ± 1.0(1.2), 1453.5 ± 1.4(0.54), 1788.6 ± 1.2(0.71), 2097.2 ± 1.0(1.32), 2111.8 ± 1.2(0.73), 2433.6 ± 3(0.05), 2656.1 ± 1.5(0.077). Coincidence spectra were taken with two NaI(Tl) detectors, and the results were analysed quantitatively. The decay scheme proposed involves levels at 559.3, 1216.6, 1788, 2112, 2434, and 2656 keV. The highest excited state is now known to have the spin of 3, and the ft-value as well as the presence of a detectable ground state transition indicate that the parity is odd and that the level should be considered as produced by octupole vibration.

663 SUM–COINCIDENCE TECHNIQUE FOR γ-RAY STUDIE
S.Jha, H.G.Devare, M.Narayana Rao and K.G.C.Pramila

Proc. Indian Acad. Sci. A, Vol. 50, No. 5, 303-13 (Nov., 1959).

The outputs of two matched scintillation spectrometers are added to give a sum peak of γ-rays in cascade and the pulses from one of the units analysed in coincidence with this sum peak, so that the resulting spectrum contains only the photopeaks of cascade γ-rays. In Eu^{154}, cascade emission of γ-rays of 320, 1280 and 123 keV was established, and it was shown that there is a β-transition of about 3% from Eu^{154} to a level in Gd^{154} at 1850 keV. Some of the peaks in the sum--coincidence spectra cannot be explained on the present decay scheme. A.E.I. Research Laboratory

664 LIFETIME OF THE FIRST EXCITED STATE OF N^{14}.
C.P.Swann, V.K.Rasmussen and F.R.Metzger.
Phys. Rev. (USA), Vol. 121, No. 1, 242-5 (Jan. 1, 1961).

The mean life was measured by nuclear resonant scattering. The $N^{14}(p,p')$ reaction with an N^{14} enriched gaseous ammonia target was used as the source of Doppler-broadened γ-radiation. The value of $(7.3 \pm 1.8) \times 10^{-14}$ sec obtained is a factor of two longer than theoretical predictions based on the wave-functions used to explain the anomalously slow C^{12} β decay.

665 GAMMA RADIATIONS FROM EXCITED STATES OF Ne^{20}.
T.A.Rabson, W.D.Barfield, D.L.Bernard, T.W.Bonner and W.W.Givens.
Nuclear Phys. (Internat.), Vol. 21, No. 1, 43-8 (Nov. (4), 1960).

Gamma radiations from excited states of Ne^{20} were measured with a lens type pair spectrometer. The nuclear reactions which were used are $F^{19}(d,n)Ne^{20}$ and $Na^{23}(p,\alpha)Ne^{20}$. Gamma radiation with Doppler corrected energies of 7.26, 8.26, 9.22, 9.98, 10.59 and 11.31 MeV were attributed to Ne^{20}. The 8.26 MeV and 10.59 MeV γ-rays are believed to be due to cascades: 9.98 → 1.63 and 12.22 → 1.63, and the remainder are due to ground state transitions. Gamma radiation was also observed with an energy of 6.67 MeV which is attributed to F^{20}, and a γ-ray with an energy of 6.17 MeV was observed and attributed to O^{16}. A search was made for nuclear pairs from a 0^+ excited state of Ne^{20} at 4.25 or 4.97 MeV using the $Na^{23}(p,\alpha)Ne^{20}$ reaction. No nuclear pairs were observed which indicates that the 4.25 MeV state is not 0^+.

666 THE IDENTIFICATION AND HALF LIVES OF FISSION-PRODUCT Rb^{92} AND Rb^{93}.
K.Fritze and T.J.Kennett.
Canad. J. Phys., Vol. 38, No. 12,1614-22 (Dec., 1960).

The existence of two new rubidium isotopes, Rb^{92} and Rb^{93}, has been established and their half lives measured. The half lives of these short-lived fission products were determined using a technique of timed precipitations. The values obtained for Rb^{92} and Rb^{93} were 5.3 ± 0.5 sec and 5.6 ± 0.5 sec respectively. The half lives of the strontium and yttrium daughters were also determined. The strontium isotopes were studied by observing the decay rate of a characteristic γ-ray peak. For Sr^{92}, the decay of the 1.37 MeV line gave a value of 2.71 ± 0.02 hr. A γ-ray peak at 590 keV, which was found to be associated with Sr^{93}, decayed with a half life of 7.54 ± 0.06 min. The half lives of the yttrium daughters were determined by β counting. The values found for Y^{92} and Y^{93} were 3.53 ± 0.02 hr and 10.1 ± 0.1 hr respectively.

667 INVESTIGATIONS OF THE DECAY-SCHEME OF Rh^{101}.
B.L.Sharma.
Nuclear Phys. (Internat.), Vol. 19, No. 5, 550-4 (Nov. (6), 1960).

Enriched Ru^{101} bombarded with 6 MeV protons was observed to emit 75, 310, and 545 keV gamma rays each decaying with a 4.4 d half-life. However, the lead and copper absorption measurements strongly indicated that the 75 keV photo peak, observed in well crystal measurements, was actually due to the Pb K X-ray, produced by the photo-electric absorption of the 310 keV gamma ray in the lead shield around the crystal. A weak 235 keV gamma ray was observed to be in coincidence with the 310 keV gamma ray previously assigned to Rh^{101}. The latter was not in coincidence with 545 keV. After the decay of 4.4 d activity, gamma rays of 127 and 198 keV were observed to be in coincidence and have a very long half-life. The 127 keV gamma ray was associated with Rh^{101} from the reported Coulomb excitation of Ru^{101} and the decay of Tc^{101}. The proposed decay scheme, having levels at 127, 310, 325 and 545 keV, is presented.

668 ANGULAR CORRELATION MEASUREMENTS ON LEVELS IN Se^{76} AND Fe^{56}.
Z.Grabowski, S.Gustafsson and I.Marklund.
Ark Fyz. (Sweden), Vol. 17, Paper 23, 411-19 (1960).

The angular distributions of cascading gamma rays in Se^{76} and Fe^{65} were investigated with an automatic directional correlation apparatus. The measured cascades in Se^{76} are (keV): 560-660, 560-1220, 560-2100, 1220-1220, 1220-1440, giving the following spins of energy levels in Se^{76}, keV(I,π):560(2+), 1216(2+), 1788(2+). 2434(3−). The first three levels may be of one, two and three phonon vibrational character respectively, and the 2656 keV level is of probable octupole vibrational type. The cascades 0.85-3.26, 1.24-2.02 and 1.24-1.76 MeV in Fe^{56} give a 3+ spin to the 4.10 MeV level and a (5+) spin level at 3.84 MeV. The spin assignment of the 4.10 MeV level is unique 3+, but it is in discrepancy with the interpretations of earlier correlation measurements.

669 MULTIPOLARITY AND CHARACTER OF 961 keV RESONANCE AND 840 keV FLUORESCENCE RADIATION IN ^{152}Sm. B.S.Sood.
Proc. Phys. Soc. (GB), Vol. 76, Pt 5, 759-62 (Nov., 1960).

The ratio of the intensities of the 961 keV resonance and 840 keV fluorescence radiation in Sm^{152} was measured, at angles ranging from 55° to 155°, and compared with theoretical values. The results were in agreement with the spin and parity assignments of 0+, 2+ and 1− to the ground, 122 keV and 961 keV states respectively.

670 γ-SPECTRA OF ^{165}Tu AND ^{167}Tu. [Tm^{165} AND Tm^{167}].
S.Chojnacki, A.Jasiński, W.Kusch, J.Kownacki, H.Lancman and J.A.Yutlandov.
Bull. Acad. Polon. Sci. Ser. Sci. math. astron. phys. (Poland), Vol. 8, No. 6, 407-11 (1960).

Scintillation spectrometer measurements on Tu^{165} confirmed γ-rays at 243, 292, 354, 453, 810, 1172 and 1398 keV. A previously unknown transition at 2007 keV was also found, and the relative intensities 1172 : 1398 : 2007 measured as 1 : 0.23 : 0.06. In Tu^{167}, lines at 208 and 527 keV were observed, relative intensities 527 : 208 being (0.059 ± 0.005) : 1. The results are consistent with spin $\frac{5}{2}^-$ for the 735 keV level in Er^{167}. A.E.I. Research Laboratory

NUCLEAR REACTIONS

(Including scattering by nuclei)

671 OBTAINING A POLARIZED HYDROGEN TARGET.
L.N.Rozentsveig and M.Ya. Azbel.
Zh. eksper. teor. Fiz. (USSR), Vol. 38, No. 5, 1556-8 (May, 1960).
In Russian.

The possibility of obtaining a polarized hydrogen, deuterium, or triton target by forming a solution in metallic foil is discussed. An example is given of the programme of measurements required to realize such targets. [English translation in: Soviet Physics — JETP (USA), Vol. 11, No. 5, (Nov., 1960)]. E.A.Sanderson

672 FLUCTUATIONS OF NUCLEAR CROSS-SECTIONS IN THE "CONTINUUM" REGION. T.Ericson.
Phys. Rev. Letters (USA), Vol. 5, No. 9, 430-1 (Nov. 1, 1960).

Consequences of the statistical assumption in the so-called "continuum" region of the compound states are studied. Infinitely good resolution in the incident beam is assumed and it is shown that nuclear reaction partial cross-sections fluctuate as a function of incident energy with a period of the order of the "width" $\Gamma = \hbar/\tau$, so that lifetime, τ, of the complex nucleus can be measured by measuring these fluctuations. It is pointed out that the formation and decay of the compound nucleus are independent only on the average. F.Herbut

Due to Photons

CROSS-SECTION ANALYSIS OF BREMSSTRAHLUNG-INDUCED ACTIVATION CURVES: APPLICATION TO $N(\gamma,n)$ AND $O(\gamma,n)$.
See Abstr. 480

673 PHOTONEUTRON DISINTEGRATION BELOW THE GIANT RESONANCE: BERYLLIUM-9 AND CARBON-13.
N.C.Francis, D.T.Goldman and E.Guth.
Phys. Rev. (USA), Vol. 120, No. 6, 2175-85 (Dec. 15, 1960).

The photoneutron cross-sections of Be^9 and C^{13} are calculated. A single-particle model is used to describe the incident bound and final continuum distorted states. Using reasonable potential well parameters, the calculated $Be(\gamma,n)$ cross-section near threshold is in agreement with experiment. Cross-sections for transitions to both the $s_{1/2}$ and $d_{3/2}$ final states in C^{12} are calculated for γ-ray energies below 10 MeV. The calculated cross-section is three times as large as the measured value at 6.4 MeV. The thermal-neutron capture cross-section in C^{12} was calculated and the error persisted in magnitude and sign. Origins of the inaccuracies in the model are discussed. Angular distribution and polarization formulae are presented.

674 FINE STRUCTURE IN THE GIANT RESONANCE FOR Cu^{63} AND Ag^{107} (γ, n) REACTIONS.

T.Nakamura, K.Fukunaga, K.Takamatsu, M.Yata and S.Yasumi.
J. Phys. Soc. Japan, Vol. 14, No. 8, 1117-18 (Aug., 1959).

The γ-ray source was a thick lithium target bombarded with 500 keV protons. By using 9 angles of emission in the range $\cos\theta = -0.8$ to $+0.8$, the excitation curves were investigated in the energy range 60 keV on either side of the 17.6 MeV line. Samples of Cu and Ag in the form of hollow cylinders were irradiated for about 20 min and their β-activities measured with two Geiger counters. For Cu^{63} there was no fine level greater than 0.2 MeV-mb, while for Ag^{107} there was some indication of fine levels less than 0.7 MeV-mb. A.Ashmore

675 THE HIGH-ENERGY PHOTODISINTEGRATION OF HELIUM, NITROGEN AND NEON.

J.M.Reid and B.Lalovic.
Proc. Phys. Soc. (GB), Vol. 76, Pt 1, 65-78 (July, 1960).

A fast expansion cloud chamber, triggered by three proton telescopes was used to investigate photonuclear reactions in helium, nitrogen and neon. Various reactions yielding from one up to seven charged fragments involving the emission of a 100 MeV proton were observed in nitrogen and neon. The results basically agree with the model of photon absorption by p—n pairs in the complex nucleus, but an unexpectedly large number of events was found in which the residual nucleus disintegrated. The assumption that in $(50 \pm 15)\%$ of the cases in which the photon is absorbed by a (p,n) pair, the residual nucleus is sufficiently excited to disintegrate, brings the results into line with previous scintillation counter experiments in which p—n coincidences were studied. A small number of (γ, p) events was found at energies substantially above the giant resonance. It was also found that 5-10% of the events occurring involved the emission of two fast protons.

676 THE PHOTODISINTEGRATION OF RARE EARTH ELEMENTS. H.H.Thies and B.M.Spicer.

Austral. J. Phys., Vol. 13, No. 3, 305-21 (Sept., 1960).

The neutron yields from praseodymium, terbium, and holmium were measured as a function of bremsstrahlung energy, and from these the shapes of the respective cross-sections were deduced. For terbium and holmium, the cross-section for photon absorption showed two peaks, in agreement with the predictions of both the hydrodynamic model and the independent-particle model of the nuclear photoeffect in non-spherical nuclei. The case of praseodymium was treated as a control experiment since this nucleus is nearly spherical. Its photon absorption cross-section had only one peak, in agreement with expectation for a spherical nucleus. The results were discussed in terms of both the hydrodynamic model and the independent-particle model. Values of the deformation parameter were deduced from the photodisintegration data and were compared with values obtained by other methods.

677 PHOTOPROTONS FROM TANTALUM. J.H.Carver, R.B.Taylor and W.Turchinetz.

Austral. J. Phys., Vol. 13, No. 3, 617-20 (Sept., 1960).

The yield of the 5.5 hr isomer produced in the reaction Ta^{181} Ta^{181}(γ,p)Hf^{180} was measured as a function of photon energy between 15 (threshold) and 30 MeV. Analysis of the decay curve was used to subtract the effect of the 2.1 hr activity from the reaction Ta^{181}$(\gamma,3n)$Ta^{178}. Absolute cross-sections were obtained by comparison with the yields of the reaction Cu^{63}(γ,n)Cu^{62} in the same beam, using the cross-section values of Berman and Brown (Abstr. 11415 of 1954). A peak cross-section of 1 mb at 28 MeV was observed. A.Ashmore

678 THE REACTION (γ,α) ON TELLURIUM. F.I. Havliček.

Nuovo Cimento (Italy), Vol. 18, No. 1, 65-9 (Oct., 1960). In German.

Nuclear emulsion loaded with tellerium oxide was irradiated with bremsstrahlung of maximum energy 33 MeV. The results show larger numbers of alpha-particles than expected.

R.H.Thomas

Due to Electrons

679 SCATTERING OF HIGH-ENERGY ELECTRONS FROM Ca^{40}, V^{51}, Co^{59}, In^{115}, Sb^{121,123}, AND Bi^{209}.

H.Crannell, R.Helm, H.Kendall, J.Oeser and M.Yearian.
Phys. Rev. (USA), Vol. 121, No. 1, 283-9 (Jan. 1, 1961).

The absolute elastic electron-scattering cross-sections were measured at a number of angles at a primary electron energy of 183 MeV. The cross-sections were obtained by comparison with scattering from the proton. These data were compared with the previous relative angular distributions measured by Hahn, Ravenhall, and Hofstadter (Abstr. 2314 of 1956). The present data are in closer agreement with the charge distributions found from fitting a Fermi two-parameter model to the order data than with those found from a fit of the Ford and Hill distributions (1955). The absolute cross-sections for Bi^{209} show the least agreement: they ar 35% larger than the predictions of the Fermi model and about 70% larger than the Ford and Hill model.

680 SCATTERING OF HIGH ENERGY ELECTRONS BY CARBON AND OXYGEN. L.V.Deshpande and V.B.Kelk

Current Sci. (India), Vol. 29, No. 10. 385-6 (Oct., 1960).

It is shown that the experimental results for C and O are identical if plotted in terms of $q\,A^{1/3}$ up to the first minimum. This is in accordance with Born approximation if the density distributions $\rho(R\,A^{-1/3})$ are identical. Comparison with an optical model analysis of the nuclear scattering of protons, indicates that the neutron dens exceeds the proton density in the core and in the periphery. There is an intermediate region of higher proton density. A.Ashmor

SCATTERING OF ELECTRONS ON Li^{6}. See Abstr. 598

681 NUCLEAR EXCITATION BY SCATTERING OF 40-MeV ELECTRONS.

W.C.Barber, F.Berthold, G.Fricke and F.E.Gudden.
Phys. Rev. (USA), Vol. 120, No. 6, 2081-90 (Dec. 15, 1960).

The electron energy spectra resulting from the scattering of 40-MeV primary electrons were measured for the purpose of studying nuclear excitations. Targets of Li^{6}, Be, C, and Si were employed at scattering angles of 132° and 160°; Pb was studied at a single angle of 160°. In addition to the elastic peaks, all spectra show peaks corresponding to excitation of the target nucleus into well-defined energy states. Peaks corresponding to known levels in Li^{6} at 2.18 and 3.56 MeV, in Be^{9} at 2.43 MeV, and in C^{12} at 15.1 MeV, were measured and analysed by a virtual photon theory to give values of $(4^{+3}_{-1.5})\times 10^{-4}$, 6.2 ± 0.6, 0.13 ± 0.03, and (40^{+8}_{-6}) eV for the values of their respective radiation widths to the ground states. Other well-defined peaks were observed at excitation energies of 16.9 MeV in Be, 11.6 MeV in Si, and 4.2 MeV in Pb. Broad peaks corresponding to the excitation of the giant resonance were observed in C, Si, and Pb, with maxima at 23, 20, and 15 MeV, respectively, and integrated cross-sections of 75, 12 and 6500 MeV-mb, respectively. These cross-sections are uncertain by a factor of approximately two because they depend on arbitrary methods used in subtracting the continuum of low-energy electrons and on arbitrary assumptions about nuclear form factors.

Due to Nucleons

682 HIGH ENERGY SCATTERING OF NUCLEONS FROM NUCLEI. T.Sasakawa.

Progr. theor. Phys. (Japan), Vol. 22, No. 5, 738-40 (Nov., 1959).

Considers whether the impulse approximation may be used for nuclei heavier than He^{4}. Predicted first diffraction minima, which depend mainly on the nuclear density distributions, seem consisten with experiment. R.J.N.Phillips

683 TOTAL CROSS SECTIONS FOR THE NUCLEAR SCATTERING OF 765 MeV NUCLEONS.

G.Z.Shah and B.M.Thaker.
Current Sci. (India), Vol. 29, No. 10, 385 (Oct., 1960).

Values of σ_T for Li, C, O, Al are calculated from the optical model using experimental values of the nucleon—nucleon cross-section to give the absorption parameter. They are in reasonable agreement with the measurements of Booth, Hutchinson and Ledley (Abstr. 1980 of 1958). A.Ashmor

684 CLASSICAL TREATMENT OF NUCLEAR REACTIONS INDUCED BY FAST NUCLEONS. K.Kikuchi.
uclear Phys. (Internat.), Vol. 20, No. 4, 590-600 (Nov. (3), 1960).

The direct process in nuclear reactions is studied using a implified classical model. The process of the usual inelastic cattering type is found to give a contribution of 10-25% to the total ross-section. The more complicated processes, in which two or nore collisions take place, seem to contribute 10% to the absorption ross-section.

685 EXCITATION OF HEAVY NUCLEI BY FAST NUCLEONS. K.Kikuchi.
uclear Phys. (Internat.), Vol. 20, No. 4, 601-13 (Nov. (3), 1960).

Nuclear reactions induced by fast nucleons are studied on the asis of a classical model. A formula is obtained to calculate the nergy spectrum of all nucleons emitted, taking account of the uccessive collisions between the incident nucleon and the nucleons n the target nucleus. The result is compared with the energy pectrum predicted by the statistical theory. Calculated energy pectra and cross-sections are found to be in fair agreement with ne experimental results.

Due to Protons

686 EFFECTS OF POTENTIAL WELL PARAMETERS ON THE POLARIZATION OF ELASTICALLY SCATTERED ROTONS. K.Nishimura.
rogr. theor. phys. (Japan), Vol. 22, No. 3, 465-6 (Sept., 1959).

The shape of the polarization curve is found not to depend in ny simple way on the well parameters; in particular, the conclusion f Sternheimer (Abstr. 3743 of 1959), that the maximum polarization nside the first diffraction peak increases as the imaginary part of ne spin—orbit potential increases, is not supported.

I.J.R.Aitchison

687 ASYMMETRY IN SCATTERING OF 90-140 MeV POLARIZED PROTONS FROM NUCLEAR EMULSION IATERIAL. J.G.Rutherglen.
roc. Phys. Soc. (GB), Vol. 76, Pt 3, 427-30 (Sept. 1, 1960).

The polarization in proton scattering from nuclear emulsion naterial was measured by a counter method at proton energies of 43, 115 and 91 MeV. The results were in good agreement with stimations based on previous results for the constituent elements f the material and provide a good calibration for experiments in vhich nuclear emulsions are used as a polarization analyser.

688 EXCITATION FUNCTIONS FOR INELASTIC SCATTERING REACTIONS OF CADMIUM-111 AND NDIUM-115. N.T.Porile.
hys. Rev. (USA), Vol. 121, No. 1, 184-92 (Jan. 1, 1961).

Excitation functions were measured for the formation of Cd^{111m} nd In^{115m} in the bombardment of Cd^{111} and In^{115}, respectively, with -10 MeV protons, 10-20 MeV deuterons, and 15-40 MeV alpha articles. The excitation function for the In^{115} $(\alpha,\alpha n)$In^{114m} reaction vas also obtained. All the excitation functions increase monotonically vith energy. The cross-sections for the formation of In^{115m} at the ighest bombarding energies are 1.5, 42, and 5.2 mb, for the proton-, euteron-, and alpha-induced reactions, respectively. The corresonding cross-sections for the formation of Cd^{111m} are 2-3 times arger. The results are compared with the predictions of the tatistical theory. A definite conclusion can only be drawn in the ase of the $(\alpha,\alpha\gamma)$ reaction where it is shown that an evaporation nechanism cannot account for the measured cross-sections at ombarding energies above 25 MeV. The contribution of Coulomb xcitation to the observed yields was calculated. It is found that this rocess contributes substantially to the $(\alpha,\alpha\gamma)$ and $(p,p\gamma)$ reactions, articularly at low bombarding energies.

689 INELASTIC SCATTERING FROM EVEN RARE EARTH ISOTOPES. B.Elbek, M.C.Olesen and O.Skilbreid.
uclear Phys. (Internat.), Vol. 19, No. 5, 523-34 (Nov. (6), 1960).

The Coulomb excitation cross sections for the first excited tate of 15 even-mass nuclei in the region of the rare earths were etermined from measurements on inelastically scattered protons nd deuterons. From the cross sections, reduced E2-transition robabilities are obtained, in general in good agreement with those erived from the directly measured lifetimes of the nuclear states. he intrinsic quadrupole moments determined from the transition probabilities show, for each element, a regular variation with the mass number, but discontinuities occur when passing from one element to another. This behaviour appears to be correlated with the variation in the moment of inertia for the same nuclei. The individual intrinsic quadrupole moments of odd-mass nuclei in the same region often deviate from the moments of the neighbouring even isotopes, but on the average the quadrupole moments of odd-mass nuclei are almost the same as those for even nuclei.

690 REDETERMINATION OF (p,γ) RESONANT ENERGIES USED AS FIXED POINTS ON THE HIGH-ENERGY SCALE. S.E.Hunt, R.A.Pope, D.V.Freck and W.W.Evans.
Phys. Rev. (USA), Vol. 120, No. 5, 1740-4 (Dec. 1, 1960).

In order to clear up a discrepancy in the existing absolute measurements of (p,γ) resonances, the proton energies at which strong fluorine and aluminum (p,γ) resonances occur were measured using a 36 in. radius absolute electrostatic analyser and compared with measurements for the lowest energy fluorine resonance which has been measured previously using a 12 in. absolute electrostatic analyser. An accuracy of 1 part in 1000 is claimed for both instruments and the disagreement was found to be less than 1.5 parts in 1000. Weighted mean values of fluorine resonances, based on two analysers, were found to be 340.7 ± 0.3, 484.3 ± 0.3, 873.5 ± 0.7, 1347.7 ± 1.0, and 1373.7 ± 0.8 keV. These are compared with the values obtained by other workers in this field, and found to be in good agreement with those of Herb et al. (Abstr. 2102 of 1949) and Bondelid et al (Abstr. 1406 of 1960) but discrepancies exist between the present measurements and those of Bumiller et al. (Abstr. 8380 of 1956).

691 ALUMINIUM (p, γ) RESONANCES WITH H_1^+, H_2^+ AND H_3^+ IONS. P.F.Dahl, D.G.Costello and W.L.Walters.
Nuclear Phys. (Internat.), Vol. 21, No. 1, 106-15 (Nov. (4), 1960).

Aluminium (p, γ) resonances were studied with H_1^+, H_2^+ and H_3^+ ions, under a variety of conditions, to clarify discrepancies between molecular ion results and results with H_1^+ ions. Thick target gamma-ray yield curves from H_2^+ ions are very asymmetric. They are accurately fitted by assuming the electron in the ion is torn away the moment the target is struck. The ensuing Coulomb force pushes the two protons apart. Proton energies in the laboratory system are substantially changed, and some protons pass through the resonance twice. Six resonance energies were measured with protons in terms of the Li(p, n) threshold at 1881.1 keV. Values obtained are (in keV) 632.8 ± 0.2, 923.4 ± 0.3, 937.7 ± 0.3, 992.4 ± 0.3, 1001.7 ± 1.0 and 1213.6 ± 0.5.

692 GAMMA RAYS FROM THE 351 keV C^{14}(p, γ) RESONANCE. D.F.Hebbard.
Nuclear Phys. (Internat.), Vol. 19, No. 5, 511-22 (Nov. (6), 1 960).

Measurements were made on the energies and the angular distributions of gamma rays from the 351 keV resonance in C^{14}(p, γ). The observed transitions in N^{15} are the cascades 10.543 → 7.309 → 0 MeV, 10.543 → 5.276 → 0 MeV and 10.543 → 7.164 → 5.276 → 0 MeV. These transitions are consistent with the decays of the 7.309 MeV and 7.164 MeV levels observed in the N^{14}(d, p) and N^{14}(n, γ) reactions. The angular distribution measurements are consistent with a $\frac{5}{2}$ spin assignment for the 10.543 MeV level, a $\frac{3}{2}$ spin assignment for the 7.309 MeV level, a $\frac{5}{2}$ assignment for the 5.276 MeV level, and a $\frac{5}{2}$ assignment (with less certainty) for the 7.164 MeV level.

GAMMA-RADIATION FOLLOWING RESONANT PROTON CAPTURE BY CHLORINE. See Abstr. 653

REACTION Er^{162,164}(p,n)Tm^{162,164} AT 6 MeV. See Abstr. 652

693 RELATIVE INTENSITY OF THE 17.2 AND 14.3 MeV GAMMA RAYS FROM THE Li^7(p,γ)Be^8 REACTION. B.Mainsbridge.
Austral. J. Phys., Vol. 13, No. 2, 204-8 (June, 1960).

The ratio of the intensities of the $(17.2 + 7/8E_p)$ and $(14.3 + 7/8E_p)$ MeV components in the γ-radiation from the reaction Li^7(p,γ)Be^8 has been measured using a 5 in. diam. by 4 in. long NaI(Tl) crystal as detector. The measurements were made from below the resonance at 441 keV to above that at 1030 keV. An absolute value of the ratio was obtained at the 441 keV resonance, using a target 5 keV thick. The value obtained was 2.30 ± 0.04. Above 800 keV, the ratio remained constant at 0.54 ± 0.08 and did not deviate from this value over the 1030 keV resonance.

R.E.Meads

694 THE ANGULAR DISTRIBUTIONS OF THE GAMMA RADIATION FROM THE $Li^7(p,\gamma)Be^8$ REACTION FROM E_p = 200 keV TO 1100 keV.

B.Mainsbridge.

Nuclear Phys. (Internat.), Vol. 21, No. 1, 1-14 (Nov. (4), 1960).

Angular distributions of the gamma radiation from the $Li^7(p,\gamma)Be^8$ reaction were measured as a function of proton energy from E_p = 200 keV to 1100 keV with targets 5 to 20 keV thick. Separation of the gamma rays corresponding to transitions to the ground state and first excited state of Be^8 showd the respective angular distributions to differ markedly in the neighbourhood of the 441 and 1030 keV resonances as a result of the interference between the resonant, even parity states and proton interactions of opposite parity. The angular distributions of the resonant gamma rays are isotropic at E_p = 441 keV and are consistent with the resonance being p-wave (J = 1+) with channel spins 1 and 2 in the ratio of 1/5; they do not lead to definite conclusions on the mechanism of the 1030 keV resonance but are not inconsistent with the resonance being p-wave (J = 1+) with channel spins 1 and 2 in the ratio 1/5, the resonance radiation being isotropic but mixed with a d and s-wave contribution in the non-resonant background. A $\cos^2 \theta$ term in the angular distributions above E_p = 460 keV which rises steadily with proton energy is attributed to d-wave proton interaction in the background.

695 TIME OF FLIGHT SPECTROMETRY OF THE NEUTRONS FROM THE (p, n) REACTION ON VANADIUM.

R.Ballini, Y.Cassagnou, C.Lévi and L.Papineau.

C.R. Acad. Sci. (France), Vol. 251, No. 7, 947-9 (Aug. 17, 1960). In French.

The neutron spectrum gave peaks corresponding to excited states of Cr^{51} at 0.75, 1.15 and 1.35 MeV. Similar states were observed from X-ray spectra. Angular distributions of the neutrons were measured for the ground state and first two excited states of Cr^{51}. Within the error (5% for the ground state, 10% for the others) they are isotropic. A.Ashmore

696 EVIDENCE FOR THE STATISTICAL MODEL OBTAINED FROM (p,n) SPECTRA OF THE ODD–EVEN ELEMENTS V, Mn, Co, Nb, Rh, AND In.

R.D.Albert, J.D.Anderson and C.Wong.

Phys. Rev. (USA), Vol. 120, No. 6, 2149-54 (Dec. 15, 1960).

Spectra of neutrons emitted from (p,n) reactions were measured for the essentially monoisotopic odd–even elements V, Mn, Co, Nb, Rh, and In. The 7-8 MeV protons used were obtained from the Livermore 90 in. cyclotron. Neutron energy distributions were determined using time-of-flight techniques. Experimental results indicate agreement with the compound statistical model of the nucleus. Relative level densities obtained in this manner were found to increase with atomic weight as theoretically expected. Assuming a level density of the form $\exp[2(a\epsilon)^{1/2}]$, values of a were obtained which varied as a = A/13.

Due to Neutrons

697 THE ELASTIC SCATTERING OF 96 MeV NEUTRONS BY NUCLEI.

G.L.Salmon.

Nuclear Phys. (Internat.), Vol. 21, No. 1, 15-20 (Nov. (4), 1960).

The differential cross-sections for the elastic scattering of neutrons of mean energy 96 MeV, have been measured out to the first diffraction minimum for lithium, beryllium, carbon, aluminium, copper, cadmium, lead and uranium.

698 OPTICAL MODEL ANALYSIS OF THE SCATTERING OF 96 MeV NEUTRONS BY NUCLEI.

P.E.Hodgson.

Nuclear Phys. (Internat.), Vol. 21, No. 1, 21-7 (Nov. (4), 1960).

Total, absorption and small-angle elastic differential cross-sections for Li, Be, C, Al, Cu, Cd, Pb and U are fitted by the optical model.

699 THE VARIATIONAL PRINCIPLE IN THE OPTICAL MODEL OF NUCLEAR REACTIONS WITH NEUTRONS.

I.Brănduş.

Stud. Cercetari Fiz. (Roumania), Vol. 9, No. 2, 251-8 (1958). In Roumanian.

The cross-section formulae for the neutron collisions with nuclei, calculated in the optical model (Abstr. 524 of 1955) on the basis of Schwinger's variational principle, are given.

700 SLOW NEUTRON RESONANCE SPECTROSCOPY.
II. Ag, Au, Ta.

J.S.Desjardins, J.L.Rosen, W.W.Havens, Jr and J.Rainwater.

Phys. Rev. (USA), Vol. 120, No. 6, 2214-26 (Dec. 15, 1960).

For Pt I, see Abstr. 9685 of 1960. The results of time-of-flight measurements of Ag, Au, and Ta resonance parameters are presented. Neutron widths are given for 79 levels in Ag to 728 eV, 55 levels in Au to 940 eV, and 62 levels in Ta to 330 eV. Radiation widths for many of the stronger levels, and in some cases resonanc J values, are obtained. The reduced neutron with width distributio are in good agreement with Porter–Thomas distributions for Au an Ta. The distribution for Ag shows a large excess of small $(2g\Gamma_n^0)$ values which are interpreted as p-wave resonances and correspond to a p-wave strength function $S_1 = (1.7 \pm 0.08) \times 10^{-4}$. The s-wave strength functions are $(0.51 \pm 0.09) \times 10^{-4}$ for Ag, $(1.5 \pm 0.3) \times 10$ for Au, and $(1.84 \pm 0.34) \times 10^{-4}$ for Ta. The observation of p-wave Ag levels is interpreted as due to a $p_{1/2}$ strength function resonance in this region. The level spacing distributions for Au and Ta agree with the expected two-population Wigner spacing distribution function but not with random or single Wigner distributions. The weighted average $\Gamma\gamma$ values are 0.148, 0.170, and 0.060 eV for Ag, Au, and Ta, respectively.

701 NEUTRON CROSS-SECTIONS IN ALUMINIUM.

G.S.Mani, G.J.McCallum and A.T.G.Ferguson.

Nuclear Phys. (Internat.), Vol. 19, No. 5, 535-49 (Nov. (6), 1960).

The (n,p) and (n,α) cross-sections in aluminium were measure for neutron energies from 12 to 21 MeV; the cross-section for the (n,2n) reaction leading to the 228 keV isomeric state in Al^{26} has been determined from the threshold to 21 MeV. The relative cros sections in the above mentioned neutron energy ranges were determined by measuring the gamma ray activity associated with the beta decay of the residual nucleus; the absolute cross-sections wer obtained by normalizing to the values measured by other workers a 14 MeV. These results are compared with the statistical theory o nuclear reactions.

702 THE CAPTURE CROSS-SECTION OF ^{197}Au FOR FAST NEUTRONS.

A.T.G.Ferguson and E.B.Paul.

Reactor Science (GB), Vol. 10, No. 1-2, 19-21 (July, 1959).

The fast neutron activation cross-section for Au^{197} was remeasured at three energies. The values depend on absolute β-ray counting and on the variation of the hydrogen cross-section with energy. The results are

E_n	$\sigma_{n\gamma}$
150 ± 15 keV	270 ± 18 mb
550 ± 30	118 ± 8
1000 ± 30	97 ± 13

703 ANGULAR CORRELATION IN $C^{12}(n,n'\gamma)C^{12}$ AT 14 MeV.

G.Deconninck and A.Martegani.

Nuclear Phys. (Internat.), Vol. 21, No. 1, 33-7 (Nov. (4), 1960).

A method is developed for measuring angular correlation in inelastic scattering of 14 MeV neutrons. Random coincidences are practically suppressed by combining time of flight and fast coincidence techniques. Angular correlation has been measured on the first excited state of C^{12} and the results are in good agreement with Banarjee and Levinson's calculations based on the distorted wave method.

704 CROSS-SECTIONS FOR THE INTERACTION OF 14.5 MeV NEUTRONS WITH MANGANESE AND COBALT.

E.Weigold.

Austral. J. Phys., Vol. 13, No. 2, 186-8 (June, 1960).

Cross-sections for various reactions produced in isotopes nea the proton number 28 by irradiation with 14.5 MeV neutrons from t $H^3(d,n)He^4$ reaction were measured. The material under examination was sandwiched between copper foils, an assumed cross-secti of 522 ± 20 mbarns for the $Cu^{63}(n,2n)Cu^{62}$ reaction being used as standard for the measurements. γ-rays or annihilation quanta fron the induced activities were counted using a 2 in. high × 1.75 in. diameter NaI(Tl) crystal. The results were as follows:

Reaction	Cross-section (mbarns)
$Cu^{65}(n,2n)Cu^{64}$	1030 ± 95
$Mn^{55}(n,2n)Mn^{54}$	825 ± 185
$Mn^{55}(n,\alpha)V^{52}$	27 ± 5
$Co^{59}(n,2n)Co^{58}$	855 ± 165
$Co^{59}(n,p)Fe^{59}$	80 ± 23
$Co^{59}(n,\alpha)Mn^{56}$	29 ± 6

R.E.Mead

705 PARAMETERS AND GAMMA-RAY SPECTRA OF NEUTRON RESONANCES IN THE ISOTOPES OF MERCURY. R.T.Carpenter and L.M.Bollinger.
Nuclear Phys. (Internat.), Vol. 21, No. 1, 66-98 (Nov. (4), 1960).

The Argonne fast chopper has been used to study the neutron resonances of mercury. The neutron transmissions of five samples of normal mercury and six isotopically enriched samples were measured in the energy interval from 10 to 30 000 eV. Twenty-eight resonances were isotopically identified and parameters, including the spin, were determined for most of them. Average values of level spacings, radiations widths, and neutron strength functions were derived from the individual parameters. The spacings and radiation widths exhibit the expected rapid increase as the doubly closed shell is approached. Unexpectedly, the total radiation widths of different resonances of Hg^{201} are found to fluctuate by a larger factor than has been previously observed in any other nuclear species. The gamma-ray spectra and the multiplicity of gamma rays from capture in these resonances were measured and both quantities were found to differ from resonance to resonance in a way that is consistent with the fluctuations in the widths. Seven high-energy gamma rays were resolved in the capture gamma-ray spectra of three resonances in Hg^{201}. The absolute intensities of the transitions were determined by a least-squares fit of the data to an experimentally determined line shape. It was found that these high-energy transitions are on the average enhanced, relative to those of lower energy, by about a factor of 15 beyond the usual E_γ^3 law. The remainders obtained by subtracting the partial widths of the seven high-energy transitions from the total radiation widths are constant, within errors, for the three resonances investigated. This indicates that the fluctuations in the total radiation width are the result of fluctuations in the intensities of the transitions of highest energy. The observed magnitude of the fluctuations is shown to be consistent with that expected from random fluctuations of the partial radiation widths.

706 THE THERMAL NEUTRON CAPTURE CROSS-SECTION AND THE RESONANCE CAPTURE INTEGRAL OF ^{100}Mo. M.J.Cabell.
Reactor Science (GB), Vol. 12, No. 4, 172-6 (Aug., 1960).

Using an activation method, the thermal neutron capture cross-section of Mo^{100}, its resonance capture integral (from 0.5 eV to ∞) and its effective capture cross-section in a lattice position of BEPO have been found to be 0.199 ± 0.005 barns, 3.73 ± 0.20 barns and 0.31 barns respectively.

707 PARAMETERS OF SOME LOW-ENERGY NEUTRON RESONANCES IN PLATINUM. J.R.Waters.
Phys. Rev. (USA), Vol. 120, No. 6, 2090-4 (Dec. 15, 1960).

Measurements of the elastic scattering of neutrons from thin platinum foils were made as a function of neutron energy using a time-of-flight technique. Scattering areas were obtained for the 11.9, 19.6, 68, and 96-eV resonances. These were combined with a thick-sample transmission measurement and transmission data from other workers to give values for the parameters of the resonances. Level spins and partial widths were derived by a least squares method.

708 THE "REACTOR" NEUTRON CAPTURE CROSS SECTION OF Y^{91}. G.M.Milton and W.E.Grummitt.
Canad. J. Phys., Vol. 38, No. 12, 1690-1701 (Dec., 1960).

A high specific activity source of Y^{91}, freed from natural uranium and rare earths, was irradiated in a high flux position in the NRX reactor. After further chemical purification, 3.6 hour Y^{92} was identified in the sample by measurement of the 3.6 MeV β-particle associated with its decay, using a scintillation spectrometer. Two such measurements have established the reactor neutron capture cross section of Y^{91} to be 1.4 ± 0.3 barns.

709 A PRECISE DETERMINATION OF THE TOTAL CROSS SECTION OF URANIUM-235 FROM 0.000818 eV TO 0.0818 eV. G.J.Safford, W.W.Havens, Jr and B.M.Rustad.
Nuclear Sci. Engng (USA), Vol. 6, No. 5, 433-40 (Nov., 1959).

The measurements were made for two types of samples, metallic foils and D_2O solutions of uranium. Balanced solutions of $U^{235}O_2(NO_3)_2$ and $U^{238}O_2(NO_3)_2$ were used to determine the difference between the total cross sections of U^{235} and U^{238}. This value when combined with the relatively small, known value of the total cross section for U^{238} gives $\sigma_T(U^{235}) = 695.0 \pm 1.8$ barns at 0.0253 eV. The measurements on the metallic U^{235} foils agreed with the measured total cross section determined from the liquid solution data to better than 1%, yielding $\sigma_T(U^{235}) = 698.7 \pm 4.7$ barns at 0.0253 eV. The measured value of the U^{235} total cross section at 0.00291 eV was combined with the scattering cross section, a recent precise value of $(1 + \alpha)$ at 0.00291 eV, and the ratio $\sigma_f(0.0253\ \mathrm{eV})/\sigma_f(U^{235}) =$ 590.8 ± 5.4 barns at the standard neutron energy of 0.0253 eV.

710 THE EFFECTIVE RESONANCE ABSORPTION INTEGRAL OF ^{238}U IN HEAVY-ATOM MIXTURES. C.Erginsoy.
Reactor Science (GB), Vol. 10, No. 1-2, 1-7 (July, 1959).

The resonance absorption of neutrons by U^{238} in admixtures containing elements of medium or high atomic weight is considered. The contributions of the eighteen resolved resonances are calculated for three different dilutions corresponding to potential scattering cross-sections per U^{238} atom of 10 barns (pure U^{238} metal), 100 barns and 1000 barns. A good approximation is obtained to the exact Hurwitz solution for a non-hydrogeneous moderator, from which the effective resonance integrals are calculated. The effect of Doppler broadening at T = 300°K is included. The region of unresolved resonances is taken from 420 eV to 1 MeV and the resonance integrals are evaluated for this region, taking into account levels associated with $l > 0$ neutrons. Important differences are found from the predictions of a simple "narrow resonance" approximation.

Due to Mesons and Hyperons

HIGH-ENERGY PION—NUCLEUS SCATTERING. See Abstr. 524

Due to Deuterons

711 ELASTIC SCATTERING OF 13 MeV DEUTERONS ON ALUMINIUM. N.Cindro, M.Cerineo and A.Strzalkowski.
Nuclear Phys. (Internat.), Vol. 21, No. 1, 38-42 (Nov. (4), 1960).

The angular distribution of 13 MeV deuterons scattered elastically on aluminium was measured by means of the thin scintillation crystal technique. Although not so prominent as at 15 MeV the increase of the differential cross-section at backward angles was also observed at the deuteron energy of 13 MeV. The reason for back angles maxima in elastic scattering has not been elucidated so far.

712 THE ELASTIC AND INELASTIC SCATTERING OF 19.6 MeV DEUTERONS BY Mg. G.W.Greenlees and J.Lowe.
Proc. Phys. Soc.(GB), Vol. 36, Pt 1, 149-57 (July, 1960).

Absolute differential cross-sections are presented for the inelastic scattering of 19.6 MeV deuterons by Mg^{24} leading to the first excited state at 1.37 MeV, in the angular range 15°-120°(c.m.). The angular distribution shows a sharp rise at forward angles ($\theta_{c.m.} < 40^0$) and a rather weak oscillation at more backward angles. It is concluded from an analysis of the results that the electric contribution to the scattering is smaller than was previously assumed, and that a distorted-wave treatment is essential if a satisfactory fit is to be achieved. Absolute differential cross-sections are also presented for the elastic scattering of 19.6 MeV deuterons by Mg.

713 THE DIRECT INELASTIC SCATTERING OF DEUTERONS. M.El-Nadi and M.Wafik.
Proc. Phys. Soc. (GB), Vol. 76, Pt 2, 185-205 (Aug., 1960).

A general expression for the differential cross-section of inelastically scattered deuterons is derived by assuming the complete antisymmetrization of the total wave-functions of the system. This is found to give rise to different possible mechanisms: (i) the direct surface scattering in which the incident deuteron itself forms the scattered particle, (ii) the nucleon exchange stripping in which one of the constituents of the deuteron is exchanged by a similar one from the target nucleus, (iii) the target nucleus stripping in which a deuteron from the target nucleus is ejected, while the rest is captured by the incident particle, and (iv) the knock-on process in which the incident deuteron knocks out a deuteron from the target nucleus and is then itself absorbed. Comparison is made between the theory and experimental data; good agreement with experiments is obtained.

714 STRIPPING REACTIONS WITH POLARIZED DEUTERONS.

R.Botzian.

Z. Phys. (Germany), Vol. 160, No. 5, 573-86 (1960). In German.

The nucleons liberated in a (d,p) or (d,n) stripping reaction are generally polarized even if unpolarized deuterons are used. These reactions are here examined for polarized deuterons in order to provide more detailed information concerning the interactions between the reaction products.

715 (d,t) REACTIONS ON NUCLEI WITH A ≅ 60.

B.Zeidman, J.L.Yntema and B.J.Raz.

Phys. Rev. (USA), Vol. 120, No. 5, 1723-30 (Dec. 1, 1960).

Energy spectra of tritons from the (d,t) reactions on a number of nuclei with masses between A = 51 and A = 68 were obtained at a deuteron energy of 21.5 MeV. The experiment was performed in a 60 in. scattering chamber, a double NaI crystal system being used for particle identification. The absolute differential cross-sections were obtained at 27° (lab) and angular distributions of various triton groups were measured over a range of angles from 7° to 70°. The angular distributions exhibit an oscillatory behaviour and are fitted with the Butler theory for neutron pickup. The angular distributions observed in the (d,t) reactions on V^{51} and Cr^{52} correspond to $l = 3$ transitions, while in the case of the other nuclei studied (Mn^{55}, Fe^{56}, Fe^{57}, Co^{59}, Cu^{63}, Cu^{65}, Zn^{64}, Zn^{66}, Zn^{67}, and Zn^{68}) both $l = 1$ and $l = 3$ transitions were observed. Evidence for the mixing of shell-model configurations is presented. The Butler formalism and empirically determined constants are used to extract reduced widths. See also following abstract.

716 ANALYSIS OF THE STRUCTURE OF NUCLEI FROM (d,t) REACTIONS.

B.J.Raz, B.Zeidman and J.L.Yntema.

Phys. Rev. (USA), Vol. 120, No. 5, 1730-7 (Dec. 1, 1960).

Discusses the use of experimentally determined reduced widths from (d,t) reactions in analysing the structure of the ground state of the target nuclei. The (d,t) reaction is an especially sensitive and almost unique experimental technique for measuring small components of nuclear wave-functions. In this role it becomes a valuable tool in investigating the presence of strong pairing forces in nuclei. This analysis demonstrates the strong mixture of the 2 $p_{3/2}$ and 1 $f_{5/2}$ neutron states in the region around A = 60. In contrast to this, nuclei with 28 neutrons show no observable mixing of states. Special attention is given to Fe^{57} and a shell-model wave-function is derived that gives the observed magnetic moment as well as the observed (d,t) reduced widths. In this connection a simple general formula is presented for the magnetic moment of any shell-model wave-function.

717 ENDOTHERMIC DEUTERON STRIPPING REACTIONS. I. STRIPPING NEAR THRESHOLD.

E.K.Warburton and L.F.Chase, Jr.

Phys. Rev. (USA), Vol. 120, No. 6, 2095-2102 (Dec. 15, 1960).

Wilkinson's explanation of the good agreement between theory and experiment for low-energy, low Q-value, (d,p) and (d,n) stripping reactions is restated from the point of view of the dispersion relations derivation of the Butler stripping formula. From this point of view, the kinematical conditions which should lead to the least distortion of the stripping pattern appear in a simple way. As a consequence of Wilkinson's arguments, it is proposed that the stripping mechanism should contribute significantly to endothermic (d,p) or (d,n) reactions near threshold. Some (d,n) threshold work is discussed, and it is concluded that this work gives some evidence that the stripping mechanism is important near threshold. The information on the reaction mechanism near threshold which can be obtained from γ-ray angular distribution measurements in (d,pγ) or (d,nγ) reactions is discussed and a general form for the angular distribution function for either plane-wave or distorted-wave stripping is developed. The $B^{11}(d,n)C^{12}$(15.1 MeV level) reaction is considered in some detail and it is concluded that the experimental evidence is consistent with this reaction proceeding via the stripping mechanism near threshold.

718 ENDOTHERMIC DEUTERON STRIPPING REACTIONS. II. $C^{12}(d,p_3\gamma)C^{13*}$ REACTION.

L.F.Chase, Jr, R.G.Johnson and E.K.Warburton.

Phys. Rev. (USA), Vol. 120, No. 6, 2103-7 (Dec. 15, 1960).

The total cross-section of the $C^{12}(d,p_3)C^{13}$ reaction ($Q = -1.13$ MeV) to the third excited state of C^{13} at 3.85 MeV was measured for deuteron energies between 1.7 and 3.1 MeV. The cross-section was obtained from the yield of the 170 keV γ-ray corresponding to the electric-dipole transition between the $\frac{5}{2}^+$, C^{13} 3.85 MeV level and the $\frac{3}{2}^-$, C^{13} 3.68 MeV level. The angular distribution of the 170 keV γ-ray relative to the deuteron beam was investigated for the same deuteron energy region by measuring yields at 0° and 90° to the beam. The measured anisotropy is compared to the predictions of plane-wave and distorted-wave stripping. The γ-ray anisotropy for deuteron energies between 1.7 and 2.4 MeV is in good agreement with the predictions of plane-wave stripping. Seven compound nucleus resonances corresponding to known N^{14} energy levels were observed between deuteron energies of 2.4 and 3.2 MeV. The Breit—Wigner single-level formula is used to extract resonance parameters for these levels.

719 THE POLARIZATION OF NEUTRONS FROM THE $^{12}C(d,n)^{13}N$ REACTION.

A.Budzanowski, K.Grotowski, H.Niewodniczański and J.Nurzynski.

Bull. Acad. Polon. Sci. Ser. Sci. math. astron. phys. (Poland), Vol. 7, No. 9, 583-7 (1959).

The polarization of neutrons from this stripping reaction was investigated for the reaction angle $\theta_{lab} = 15°$ and a deuteron energy of 12.9 MeV. The neutron polarization connected with the 3.56 MeV energy level in N^{13} was found to be $-(0.39 \pm 0.11)$.

720 REACTIONS $N^{14}(d,n)O^{15}$(g.s.) AND $N^{14}(d,n)O^{15*}$ (6.79 AND 6.86 MeV).

A.J.Elwyn, J.V.Kane, S.Ofer and R.Pixley.

Phys. Rev. (USA), Vol. 120, No. 6, 2207-11 (Dec. 15, 1960).

The angular distribution of neutrons from the reaction $N^{14}(d,n)O^{15}$(g.s.) was measured at eight bombarding energies between 1.35 and 2.8 MeV. The same measurements were made on the neutron groups (unresolved) from the reactions $N^{14}(d,n)O^{15*}$(6.79 MeV) and $N^{14}(d,n)O^{15*}$(6.86 MeV) at bombarding energies of 2.55 and 2.7 MeV. Direct-interaction mechanisms are thought to be responsible for most of the observed yields, although resonance-like effects are also seen. Neutron yields at forward angles show approximate Butler stripping behaviour at all energies in addition to other unexplained processes. The observed yields at large angles can be partially explained by the exchange stripping reaction in the high-Q reaction but can not be explained on this basis for the low-Q reactio

721 STRIPPING ANALYSIS OF THE REACTION $Na^{23}(d,p)Na^{24}$.

F.A.El Bedewi and M.A.El Wahab.

Nuclear Phys. (Internat.), Vol. 21, No. 1, 49-54 (Nov. (4), 1960).

A heavy particle magnetic spectrograph was used to study the energies and angular distributions of proton groups emitted from a sodium target bombarded with 8.60 MeV deuterons. New excited states in Na^{24} were observed at 4.74 ± 0.04 MeV and 5.13 ± 0.08 MeV. The angular distributions of some proton groups were compared with curves calculated from deuteron stripping theories. While an s- or d-wave neutron capture is observed for the low lying levels, a p-wave is found to dominate the higher excited states.

722 ABSOLUTE (d,α)-REACTION CROSS SECTIONS OF ZIRCONIUM, MOLYBDENUM, TITANIUM, AND SULFUR.

O.U.Anders and W.W.Meinke.

Phys. Rev. (USA), Vol. 120, No. 6, 2114-19 (Dec. 15, 1960).

Absolute cross-sections for 7.8-MeV deuterons were measured for the following reactions: $Zr^{94}(d,\alpha)Y^{92*}$; $Zr^{92}(d,\alpha)Y^{90*}$; $Zr^{90}(d,\alpha)Y^{88*}$; $Mo^{97}(d,\alpha)Nb^{95*}$; $Mo^{97}(d,\alpha)Nb^{95*}$; $Mo^{98}(d,\alpha)Nb^{96}$; $Mo^{92}(d,\alpha)Nb^{90}$; $Ti^{46}(d,\alpha)Sc^{44}$; $Ti^{48}(d,\alpha)Sc^{46}$; and $S^{34}(d,\alpha)P^{32*}$. Excitation functions were also determined for the reactions indicated with an asterisk. Beam intensity was determined with a Faraday cage coupled to a current integrator able to measure the current with less than 1% error. The reaction products from the thin targe were chemically purified by carrier-free separations. The absolute disintegration rates were determined by 4π beta counting and coincidence gamma counting. Carrier-free tracer techniques were used to establish the yields of chemical purification steps.

Due to Alpha-particles

723 THE ELASTIC SCATTERING OF HELIUM 3 BY MEDIUM WEIGHT NUCLEI.

P.E.Hodgson.

Nuclear Phys. (Internat.), Vol. 21, No. 1, 28-32 (Nov. (4), 1960).

The experimental results of Greenlees and Rowe on the elastic scattering of He^3 by nickel, palladium, cadmium and tin are analysed by the optical model. The scattering cross-section is found to be more sensitive to the diffuseness of the nuclear surface than to the other parameters of the nuclear potential. The values found for the Saxon—Woods diffuseness factor a for Ni, Pd, Cd and Sn are respectively 0.61 ± 0.02, 0.61 ± 0.02, 0.52 ± 0.03, and 0.50 ± 0.02 × 10^{-13} cm.

724 ON THE STRIPPING OF TWO NUCLEONS.
H.C.Newns.

Proc. Phys. Soc. (GB), Vol. 76, Pt 4, 489-96 (Oct. 1, 1960).

Formulae are obtained for the differential cross-sections of the (He^3, p), (t, p) and (d, α) reactions in which the structure of the projectile and captured nucleons is taken into account. The relationship of these formulae to the results of earlier theories in which the structure was neglected is considered. The application of the theory to the interpretation of experimental results is discussed.

539.17

725 DIFFERENTIAL CROSS-SECTION OF THE REACTION C^{13}(He^3, α)C^{12} at 1.8 MeV.
R.Barjon, M.Lambert and J.Schmouker.

Nuclear Phys. (Internat.), Vol. 20, No. 4, 614-20 (Nov. (3), 1960). In French.

The differential cross-section was studied using He^3 ions from a Van de Graaff accelerator, and scintillation counters for α-particle counting.

726 SCATTERING OF α-PARTICLES FROM NUCLEI.
W.Haeberli.

Experientia (Switzerland), Vol. 16, No. 6, 217-22 (1960).

Experimental work on the scattering of α-particles is reviewed at an elementary level. Rutherford's pioneer work is first described. Then, using a classical description, the change from Coulomb to nuclear scattering at small impact parameters is introduced. Results are quoted for heavy elements which show the change, and also the diffraction type pattern described by the optical model. For light elements resonance effects at large angles are quoted and their explanation given. A.Ashmore

727 REACTION C^{12}(α,d)N^{14}.
B.G.Harvey and J.Cerny.

Phys. Rev. (USA), Vol. 120, No. 6, 2162-8 (Dec. 15, 1960).

The deuteron energy spectra were measured, reaction being induced by 47.5 MeV helium ions. Angular distributions are given for the deuteron groups corresponding to formation of the ground state and 3.95 MeV level of N^{14}. Formation of the 2.31 MeV 0+, T = 1 level of N^{14} was not observed; the cross-section was less than 3% of the cross-section for formation of the 1+, T = 0 ground state. It is suggested that this cannot be interpreted as strong evidence for the conservation of isotopic spin for two reasons. First, several well known T = 0 levels were not populated to an observable extent. Second, the reaction leading to the T = 1 level would involve a transition from a 0+ level to a 0+ level, and such transitions in (α,d) or (d,α) reactions involve difficulties with angular momentum and parity conservation in addition to nonconservation of isotopic spin, which requires $\Delta T = 0$.

728 THE (α, t) REACTION ON Li^7, Be^9 and Na^{23}.
N.A.Vlasov, S.P.Kalinin, A.A.Ogloblin and V.I.Chuev.

Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 5(11), 1468-70 (Nov., 1960). In Russian.

The reaction was studied at 40 MeV. Both the triton angular distributions and the triton spectra at small angles are shown. A comparison of the probabilities of excitation of the same levels in the residual nuclei due to the reactions (α, t), (d, n) and (d, t) is made. The (α, t) case differs greatly both from the (d, t) case, as expected, and from the (d, n) case, the latter indicating that in the (α, t) reaction it is not the one-particle proton levels which are primarily excited as in the (d, n) reaction, and that the mechanism of the (α, t) reaction is basically different from the stripping mechanism. [English translation in: Soviet Physics—JETP (USA)]. F.Herbut

729 (He^4,Be^7) REACTION IN MAGNESIUM, ALUMINUM, TITANIUM, COBALT, AND COPPER FROM THRESHOLD TO 42 MeV.
R.H.Lindsay and R.J.Carr.

Phys. Rev. (USA), Vol. 120, No. 6, 2168-74 (Dec. 15, 1960).

Cross-sections for the production of Be^7 in the He-ion bombardment of Mg, Al, Ti, Co, and Cu were measured in the 30-42 MeV energy range. The excitation functions for these reactions are presented. A study of the bulk (0°-90°; 90°-180°) laboratory angular distributions by the catcher foil technique of the Be^7 nuclei emerging from 2.0 and 1.85 mg/cm^2 magnesium targets and an examination of the approximate range—energy curves for the Be^7 particles in aluminium and magnesium indicates that the reaction proceeds through a compound nucleus. The experimental excitation function for the Al^{27}(He^4,Be^7)Na^{24} reaction is compared with calculations based on the nuclear evaporation model. The cross-sections for the production of Na^{24} and Be^7 in the He-ion bombardment of aluminium are contrasted and the difference between the yields leads to an excitation function for the (He^4,He^{3}He^4) reaction.

730 (α, p) REACTIONS IN MEDIUM WEIGHT ELEMENTS.
N.O.Lassen and V.A.Sidorov.

Nuclear Phys. (Internat.), Vol. 19, No. 5, 579-88 (Nov. (6), 1960).

Thin targets of V^{51}, Co^{59}, Ni^{58}, Ni^{60}, Cu^{63} and Cu^{65} were bombarded with α-particles of lab. energies of 19.3, 17.8, 16.3 and 11.9 MeV. The spectra of emitted protons at 45°, 90° and 135° were measured by means of an ionization chamber. Two groups of protons were seen. One group contains almost exclusively protons boiled off from the compound nucleus and only a very small number of protons created in direct interactions. The other group with energies below the Coulomb barrier contains protons emitted from daughters of the compound nucleus, i.e., secondary protons from (α, np), (α, 2p), and (α, αp) reactions. Both groups show symmetry around 90°. The first group is only slightly anisotropic, while the second group exhibits a considerably higher anisotropy, indicating higher angular momenta for the secondary emitted protons. Using the formula from the statistical theory, the variation of the level density ρ with the excitation energy E* was deduced from the spectral shape of the first group of protons. For the range of excitation energies 6-10 MeV, the spectra are consistent with a constant temperature of the order of one MeV. However, the values obtained for the temperature increase with increasing energy of the bombarding α-particles.

Due to other Particles and Nuclei

731 SOME (t, p) REACTIONS IN LIGHT NUCLEI.
A.A.Jaffe, F. de S.Barros, P.D.Forsyth, J.Muto, I.J.Taylor and S.Ramavataram.

Proc. Phys. Soc. (GB), Vol. 76, Pt 6, 914-28 (Dec. 1, 1960).

The (t, p) reactions induced in the target nuclei B^{10}, C^{12}, O^{16} and Al^{27} were investigated at an incident triton energy of 5.5 MeV. The angular distributions of the observed proton groups were compared with a theory of double stripping and good agreement was obtained with the theoretical predictions for transfers of 0, 1, 2 and (more tentatively) 3 units of orbital angular momentum. A new level in B^{12} at an excitation of 4.297 MeV was found. Spin and parity assignments were made for the levels of C^{14} at excitations of 6.582 MeV (1^-), 6.725 MeV (probably 3^-), a hitherto unreported level at 7.009 MeV (0^+) and at 7.335 MeV (probably 2^-). The existence of levels in O^{18} at 3.634 and 4.449 MeV was confirmed and the spins and parities were determined to be 0^+ and 3^- respectively. The spin and parity of the state in O^{18} at 3.915 MeV excitation were also determined as 2^+. The behaviour of the O^{16}(t,p)O^{18} reaction leading to the ground and first four excited states of O^{18} was found to be consistent with the O^{18} configurations predicted by the intermediate-coupling theory. The atomic mass excess of Al^{29} was found to be −9.647 ± 0.015 MeV and the excitations of forty-two new levels of Al^{29} were measured.

732 INELASTIC SCATTERING OF N^{14} BY C^{12}.
M.L.Halbert and A.Zucker.

Phys. Rev. (USA), Vol. 121, No. 1, 236-42 (Jan. 1, 1961).

Inelastic scattering of N^{14} by carbon was studied at 27.3 MeV using two surface-barrier counters to detect both the scattered and the recoil particle in coincidence. The cross-section for excitation of C^{12} to the first excited state (4.43 MeV) varies only slightly with angle and averages about 0.5 mb/sr. This is about 15 times greater than the theoretical cross-section for Coulomb excitation. The cross-sections for scattering to the second, third, and fourth excited states in N^{14} were found to be only 15 to 25% of that for the 4.43 MeV excitation in C^{12}. Scattering to the first excited state of N^{14} was not observed, which is consistent with conservation of isotopic spin.

733 APPARATUS FOR THE INVESTIGATION OF HEAVY ION INDUCED REACTIONS.
C.E.Anderson, A.R.Quinton, W.J.Knox and R.Long.

Nuclear Instrum. and Methods (Internat.), Vol. 7, No. 1, 1-10 (April, 1960).

An integrated system for studying nuclear reaction mechanisms is described, including detection and identification of particles, and analysis and storage of data. Reaction products ranging from protons to fission fragments are identified and their energies are measured. Observations are made with 1° angular resolution at any angle from $8\frac{1}{2}°$ to $171\frac{1}{2}°$. Without loss of vacuum the detectors may be moved or calibrated and the target may be changed. By a combination of photographic recording and multichannel analysis, products with cross-sections ranging down to fractions of a millibarn can be measured in the presence of products having large cross-sections. Examples are shown of spectra of protons, alpha particles, fission fragments and fragments ranging from lithium to magnesium produced by heavy ion bombardment.

734

EVAPORATION OF CHARGED PARTICLES FROM HIGHLY EXCITED COMPOUND NUCLEI.

W.J.Knox, A.R.Quinton and C.E.Anderson.
Phys. Rev. (USA), Vol. 120, No. 6, 2120-8 (Dec. 15, 1960).

Energy spectra and angular distributions of alpha particles and protons emitted in the bombardment of Ni targets with 160 MeV oxygen ions were measured. The initial compound nucleus is characterized approximately by $Z = 36$, $A = 75$, total excitation energy = 125 MeV, and r.m.s. angular momentum = $5\hbar$. The energy distributions have the shapes of evaporation spectra although they are displaced by several MeV toward lower energies compared to calculated evaporation spectra. The angular distributions are approximately symmetric about 90° and sharply peaked in the forward and backward directions. At all energies there is some excess of particles in the forward direction and at high energies the distributions are predominantly forward peaked. Most of the particles are believed to be evaporated from compound nuclei with angular distributions determined by the high angular momenta of the emitting systems. The angular distributions can be fitted by a theory with a single adjustable parameter which is related to the variation of level density with angular momentum and the incoming and outgoing angular momenta. The total cross-section for alpha-particle production is 2.6 ± 0.6 barns and for protons 4.0 ± 1.0 barns. These cross-sections are larger than the estimated cross-section for compound nucleus formation, indicating that several charged particles are evaporated per interaction. About half the collision cross-section is believed to result in compound nucleus formation.

735

NUCLEON TRANSFER REACTIONS IN GRAZING COLLISIONS OF HEAVY IONS.

R.Kaufmann and R.Wolfgang.
Phys. Rev. (USA), Vol. 121, No. 1, 192-205 (Jan. 1, 1961).

Reactions in which several nucleons are transferred between complex nuclei were studied by measurement of angular distributions and excitation functions of the recoiling projectile residues. The results show that multinucleon transfer does not proceed either through a compound nucleus or through a mechanism in which the Coulomb barrier is not penetrated (such as the tunnelling mechanism for single-nucleon transfer). Instead, the data indicate the existence of a "grazing contact" mechanism. In such a grazing reaction, it appears that a high-energy projectile, though deflected by the Coulomb barrier, still penetrates the region of nuclear binding of the target. It moves along the surface of the target, with the zone of contact between the nuclei being frictionally excited and thus preventing formation of a compound nucleus. The system separates after half a rotation, or less, because the repulsive Coulombic and centrifugal forces exceed the nuclear binding force. Depending on the mode of separation, such grazing contact may result in nucleon transfer, inelastic scattering, or breakup of the projectile. At energies well above the Coulomb barrier, such grazing processes appear to represent an important fraction of the geometric cross-section. See also following abstract.

736

SINGLE-NUCLEON TRANSFER REACTIONS OF F^{19}, O^{16}, N^{14}, AND C^{12}. R.Kaufmann and R.Wolfgang.

Phys. Rev. (USA), Vol. 121, No. 1, 206-8 (Jan. 1, 1961).

Results on the angular distribution of single-neutron stripping products are presented. Beams of F^{19}, O^{16}, N^{14}, and C^{12} having an energy of 10 MeV per nucleon, and beams of O^{16} at lower energies, were used in conjunction with a rhodium target. The relative contribution of tunnelling and grazing transfer processes is discussed. The form of the angular distributions of products originating from the tunnelling mechanism is very similar in all systems, although the magnitude of the F^{19} cross-section is unexpectedly large. The cutoff distance for closest approach in a tunnelling event is found to correspond to the cutoff for elastic scattering.

737

EXCITATION FUNCTION OF THE REACTION $Be^9(Li^7,Li^8)Be^8$. R.J.Gerbracht and B.L.Youtz.

Phys. Rev. (USA), Vol. 120, No. 5, 1738-9 (Dec. 1, 1960).

The cross-section and thick-target yield as a function of energ are derived over the laboratory energy range 1.1 to 4.0 MeV. A model is assumed in which the Li^7 picks up the final, loosely-bound neutron of Be^9 only at radial positions considerably outside the nuclear surface, direct reactions being prevented by the Coulom repulsion.

738

DIFFERENTIAL CROSS SECTIONS OF THE $Be^9(Li^6,\alpha)B^{11}$ REACTION. J.J.Leigh and J.M.Blair.

Phys. Rev. (USA), Vol. 121, No. 1, 246-52 (Jan. 1, 1961).

The differential cross-sections were measured as a function of energy and angle. The α-particles leaving the B^{11} in the ground state, α_0, in the first excited state, α_1, and in the second and third excited states, $\alpha_2 + \alpha_3$, were observed at 10° intervals from 10° to 160° (lab system) at Li^6 energies of 3.00, 3.25, and 3.50 MeV, and at 20°, 60°, 90°, 120° and 160° (c.m. system) at Li^6 energies of 2.00, 2.50, 3.75, and 4.00 MeV. The angular distributions of the α_0 and α_1 groups are asymmetric about 90° c.m. Relative maxima occur at both large and small angles for each of the α-particle groups, with the yields at large angles being comparable to those at small angles In all cases the angular distribution varies slowly with bombarding energy and the yields at each angle increase monotonically with increasing energy. At 3.50 MeV the total cross-sections are 0.97 ± 0.38 mb for α_0 and 0.65 ± 0.26 mb for α_1. The experimental results suggest that the reactions proceed mainly by direct-interaction mechanisms. The similarity of the angular distributions of the $Be^9(Li^6,\alpha)B^{11}$ and the $Be^9(He^3,p)B^{11}$ reactions is pointed out.

Q VALUES OF $C^{12} + He^3$ REACTIONS. See Abstr. 645

739

POSSIBILITY OF A STRIPPING MECHANISM IN TRANSFORMATIONS INDUCED BY LITHIUM IONS.

G.C.Morrison.
Phys. Rev. (USA), Vol 121, No. 1, 182-3 (Jan. 1, 1961).

Angular distributions of the reaction $Li^7(Li^6,d)B^{11}$ leading to the ground state and first three excited states of B^{11}, and the reaction $Li^6(Li^7,t)B^{10}$ leading to the ground state and first excited state of B^{10} were studied at an incident energy of 2.1 MeV. The principal features of the observed distributions are their asymmetry about 90° and slow variation of cross-section with angle. The results suggest that the reactions proceed at least in part by a stripping mechanism with the capture of the alpha-particle core of the lithium projectile. The importance of this mechanism to the experimental investigation of the cluster model is indicated.

740

ANGULAR DISTRIBUTIONS OF $(^{14}N, \alpha)$ REACTIONS.

T.Kammuri and R.Nakashima.
Progr. theor. Phys. (Japan), Vol. 22, No. 3, 458-9 (Sept., 1959).

A stripping mechanism is proposed to account for diffraction effects in the angular distribution of α-particles emitted when Al^{27} and O^{16} are bombarded by 28 MeV N^{14} nuclei. The N^{14} nucleus is regarded as an α-particle bound to a B^{10} core in a state of zero relative angular momentum. The problem is treated in Born approximation, with a cut-off radius parameter for the B^{10}—target interaction. Preliminary calculations are compared with the $O^{16}(N^{14},\alpha)\,Al^{26*}$ data. I.J.R.Aitchiso

Nuclear Fission

741

THE TEMPERATURE DEPENDENCE OF THE FISSION CROSS-SECTIONS OF Pu^{239}, U^{235}, AND U^{233}.

C.B.Bigham.
Nuclear Sci Engng (USA), Vol. 6, No. 5, 379-85 (Nov., 1959).

The dependence on neutron temperature of the ratio of thermal neutron fission cross-sections, $\sigma(Pu^{239})/\sigma(U^{235})$ and $\sigma(Pu^{239})/\sigma(U^{23}$ were measured in heavy water moderator. Satisfactory agreement was obtained with the temperature dependence of the cross-sections for Maxwellian neutron spectra calculated by Westcott from the neutron cross-section energy dependence. Measurements were als made of the spatial distribution of neutron temperature in a tank of heavy water. At the side of the tank facing the graphite thermal column neutron source, an apparent temperature difference betwee neutron temperature and D_2O temperature (initially 44°C) decrease with a relaxation length of about one inch for points inside the tank.

742 THE AVERAGE NUMBER OF NEUTRONS EMITTED IN THE FISSION OF ^{233}U BY 14.8 MeV NEUTRONS.

A.N.Protopopov and M.V.Blinov.
Atomnaya Energiya (USSR), Vol. 5, No. 1, 71 (1958). In Russian.
English translation in: Reactor Science (GB), Vol. 10, No. 1-2, 65 (July, 1959).

The measurements were made using a double ionization chamber comprising two identical parallel plate chambers having a common cathode. Platinum disks coated with a layer of U^{233} were placed on either side of the cathode. Each chamber served not only as a fission detector but also as a detector of neutrons emitted in fissions occurring in the other chamber. The apparatus was placed alternately in a fast and a slow neutron beam and the coincidence pulses caused by simultaneous fission events in both chambers were counted. The ratio ν/ν_{T} obtained from these measurements was 1.74 ± 0.16, after appropriate corrections had been applied. Using the value ν_{T} = 2.52 ± 0.03, the average number of neutrons emitted per U^{233} fission induced by 14.8 MeV neutrons is 4.4 ± 0.45.

743 MASS DISTRIBUTION OF THE FRAGMENTS FROM THE 14.6 MeV FISSION OF U^{235}, U^{238}, AND Pu^{239}.

A.N.Protopopov, G.M.Tolmachev, V.N.Ushatski, R.V.Venediktova, .T.Krisuk, L.P.Rodionova and G.V.Yakovleva.
Atomnaya Energiya (USSR), Vol. 5, No. 2, 130-4 (1958). In Russian.
English translation in: Reactor Science (GB), Vol. 10, No. 1-2, 80-4 July, 1959).

The study of fission fragment mass distributions leads to a etter understanding of the mechanism of fission in heavy nuclei. At the same time, a knowledge of the relative fission fragment yields s of practical use in a number of radioisotope applications. This aper describes an experimental technique which has been used to etermine the relative yields of some of the fragments produced in he fission of U^{235}, U^{238}, and Pu^{239} by 14.6 MeV neutrons. The esults are presented in the form of fission fragment mass distribution curves and some of the more interesting features of these urves are discussed.

744 ANISOTROPY OF THE 14 MeV NEUTRON INDUCED FISSION OF U^{238}. A.N.Protopopov and V.P.Eismont.

Atomnaya Energiya (USSR), Vol. 6, 644 (1959). In Russian.
English translation in: Reactor Science (GB), Vol. 12, No. 4, 191-3 (Aug., 1960).

A double ionization chamber was used to record the angular dis-ribution of U^{238} fission fragments produced by 14.4 MeV neutrons. t was found that to within 3 per cent the light and heavy fragments are distributed symmetrically about a direction normal to the axis of the neutron beam. The directions in which the light and heavy ragments are emitted are of equal probability, whether the fission is symmetric or otherwise. If the mass ratio is less than 1.7-1.8, the angular anisotropy increases with the mass asymmetry. The results are discussed in terms of Strutinskii's statistical theory.

745 FISSION OF U^{238} WITH μ^--MESONS. A.C.Mihul and M.G.Petraşcu.

Stud. Cercetari Fiz. (Roumania), Vol. 9, No. 4, 465-8 (1958). In Roumanian.

200 μ NIKFI-R plates loaded with 0.055 g/cm^3 uranium were exposed to μ^--mesons. 26 975 μ-mesons coming to rest in emulsion were observed and 59 fission events were found. The uranium fission probability was calculated in two cases: under Fermi—Teller z law assumption and on the basis of the experimental works of Telegdi and others (Abstr. 1856 of 1958). The results are compared with photofission data.

746 FISSION OF Au^{197} AND Bi^{209} BY C^{12} AND O^{16} PROJECTILES. H.C.Britt and A.R.Quinton.

Phys. Rev. (USA), Vol. 120, No. 5, 1768-77 (Dec. 1, 1960).

Using a proportional counter, measurements were made of the ission fragment angular distributions, kinetic energy spectra, and he total fission cross-sections for the reactions C + Au, O + Au, C + Bi, and O + Bi at 10.5 MeV per nucleon bombarding energies and or the C + Bi reaction at energies from 72 to 126 MeV. The results how the kinetic energy spectra to be independent of the excitation of he compound system and the most probable fragment kinetic energies to be 75 ± 3 and 81 ± 3 MeV for the gold and bismuth target reactions, respectively. In all cases the fission cross-sections are ound to be only 60-80% of the estimated compound-nucleus forma-ion cross-sections. The angular distributions are fitted by the heory of Halpern and Strutinski, and an attempt is made to determine some of the qualitative features of these heavy-ion reactions.

747 TRIPARTITION IN THE SPONTANEOUS-FISSION DECAY OF Cf^{252}.

M.L.Muga, H.R.Bowman and S.G.Thompson.
Phys. Rev. (USA), Vol. 121, No. 1, 270-4 (Jan. 1, 1961).

The long-range α-particles associated with spontaneous-fission decay were studied by means of nuclear-emulsion techniques. The alpha energy spectrum was found to peak at about 19 MeV with a half-width of 10 MeV, and the preferential angle of emission was found to be slightly less than 90° with respect to the light fission fragment. These results support the view that alpha emission occurs at the time of scission and that the direction is determined by the extent of electrostatic repulsion by the fragments. A trend toward a more nearly symmetric mass division in fission accompanied by alpha emission is indicated. The frequency of occurrence of the long-range α-particles was observed to be 1 in 415 ± 10% binary fissions. Ternary events consisting of two heavy fragments and one light fragment of short range were observed, but the frequency with which these events occur was not measured. A parallel search was made for ternary-fission events in which fragmentation into comparable masses occurs.

748 HIGH-ENERGY ALPHA PARTICLES AND TRITONS FROM THE SPONTANEOUS FISSION OF CALIFORNIUM-252. J.C.Watson.

Phys. Rev. (USA), Vol. 121, No. 1, 230-1 (Jan. 1, 1961).

The energy spectra of alpha particles and tritons were measured using an E—dE/dx caesium iodide scintillator-proportional counter detector. The alpha-particle energy spectrum peaks at 16 MeV, with a full width at half maximum of about 15 MeV. The tritons peak at about 8 MeV, with a half-width of 7 MeV. One alpha particle is observed per 345 ± 20 fission events, one triton per 4500 ± 900 fission events.

Thermonuclear Reactions

749 STUDIES OF NEUTRON PRODUCTION IN LINEAR DEUTERIUM PINCHES.

P.Ohlin, K.Siegbahn, T.Sundström and S.Svennerstedt.
Nuclear Instrum. (Internat.), Vol. 3, No. 4, 237-44 (Oct., 1958).

With the experimental set-up, described earlier (Abstr. 17645 of 1960), further studies of high current linear deuterium pinches have been made. The stabilizing effect of an external magnetic field has been investigated. This effect has appeared in two ways. Firstly, peaks in the voltage curves and dips in the current curves, which are interpreted as due to sausage instabilities, disappear at $B_z > 400$ gauss. Secondly, the number of subsequent pinches is increased by the field and as many as six consecutive pinches have been observed. The dependence of the neutron yield on the magnetic field has been found to be very weak, the yield decreasing only by a factor of 2/3 for 760 gauss. The influence of the gas pressure on the number of neutrons produced has been studied in the region 9 to 30 microns. For $B_z = 0$ a slight decrease in the neutron yield with increasing pressure has been observed, With the field applied the yield seems to be almost independent of the pressure. The resistance of the discharge has been found to decrease to 0.01 ohm within the first tenths of the discharge period. The results are discussed in connection with the results of other investigators.

NUCLEAR POWER STUDIES

750 A STUDY OF THE EXPERIMENTAL NUCLEAR REACTOR VVR-S.

N.A.Lazukov, I.E.Chelnokov and V.P.Ivanov.
Atomnaya Energiya (USA), Vol. 5, No. 1, 44-51 (1958). In Russian.
English translation in: Reactor Science (GB), Vol. 10, No. 1-2, 57-63 (July, 1959).

The results of a study of the nuclear parameters required for the start-up and operation of the VVR-S reactor are given. The critical mass, the maximum and operating charges, and the reactivity equivalent of the control and safety rods have been determined. The effects upon the reactivity of changing the temperature of the water in the core, the type of reflector, etc. were also studied. In addition, the neutron density distributions along the radius and axis of the core were measured, and the speed of operation of the rods was checked.

751 SIMPLIFIED SIMULATION OF A BOILING WATER REACTOR POWER PLANT.

R.E.George and A.Sesonske.
Nuclear Sci. Engng (USA), Vol. 6, No. 5, 409-13 (Nov., 1959).

Using analogue computer facilities available at most universities, a boiling water reactor power plant was simulated in order to study for instructional purposes the system response to various deviations from normal operation conditions. The rather idealized model, which was similar to EBWR, was found to be quite stable and to behave qualitatively in a manner expected from boiling reactor experience.

752 ON THE KINETICS OF BOILING WATER REACTORS.

A.Kirchenmayer.
Reactor Science (GB), Vol. 12, No. 4, 155-61 (Aug., 1960),

Under certain assumptions the transfer functions which are necessary for a theoretical consideration of the stability of the boiling-water reactor can be derived. As these functions are fairly complicated, approximations are desired. In this paper an approximation is given, in which the influence of the spatial dependence of power is considered. The results are discussed in relation to experimental experience with EBWR.

753 THE STABILITY OF A NUCLEAR POWER PLANT.

A.S.Kochenov.
Atomnaya Energiya (USSR), Vol. 7, 122 (1959). In Russian. English translation in: Reactor Science (GB), Vol. 12, No. 4, 194-200 (Aug., 1960).

Studies are made of the stability of a nuclear power source consisting of a water-cooled, water-moderated reactor that has a negative temperature coefficient of reactivity, a saturated-steam generator and a turbine. It is assumed that the system has only two regulators, a throttle before the turbine and a constant-level device for the boiler water. Single-group kinetic equations are used, taking account of one group of delayed neutrons; the perturbations are assumed small, and non-linear equations are linearized. The stability of the system is discussed.

754 NEW IDEAS FOR NUCLEAR REACTORS.

E.P.Wigner.
Nuclear Sci. Engng (USA), Vol. 6, No. 5, 420-32 (Nov., 1959).

Estimates of world energy resources are summarized. It is pointed out that the great effort to exploit nuclear energy can be justified only if it is directed toward a full utilization of uranium and thorium. Without breeding, nuclear fuels will only supply energy for a few decades in the future energy-hungry world. Recent findings on nuclear reactor stability are discussed and the value of computing machines in theoretical studies is noted. A commentary on current concepts in reactors is presented: the flux trap reactor, boiling reactors, gas-cooling, and breeders using beryllium or U^{238} for possible improvement of neutron economy. Direct conversion of nuclear heat into electricity is briefly reviewed. Thermocouple batteries and thermionic converters are described and some remarks are made concerning their future development.

755 THE POWER NOISE TRANSFER FUNCTION OF A REACTOR. M.N.Moore.

Nuclear Sci. Engng (USA), Vol. 6, No. 5, 448-52 (Nov., 1959).

A formalism is developed to calculate the power noise transfer function for any kinetic model under the assumption that noise may originate in any or all loops of the system. Reactor kinetic equations are generalized to the macrostochastic equations satisfied by the pile noise. From these, the differential equations of the various correlation functions are determined and solved for the noise spectra. The case of a single feedback, one-delay group model is treated in detail.

756 ANALYSIS OF THE ZERO POWER REACTOR TRANSFER FUNCTION. H.C.Corben.

Nuclear Sci. Engng (USA), Vol. 6, No. 6, 461-5 (Dec., 1959).

Algebraic expressions for the amplitude and phase of the zero power transfer function allow these quantities to be evaluated from measured precursor data without the use of a digital computer. The asymptotic forms of the amplitude and phase for large and small values of ω are particularly simple. The expressions show the conditions under which the gains should be frequency-independent and yield a simple formula for the angular frequency ω_0 at which the phase angle reaches a maximum. The inhour relation is shown to be intimately related to the transfer function, the reactivity in dollars for any period α^{-1} less than one second being equal to $(1-\tan\epsilon)$, where ϵ is the phase angle at $\omega = \alpha$. The value of α corresponding to prompt critical is shown to be always equal to ω_0.

757 BREEDING POTENTIAL OF THERMAL REACTORS.

J.Chernick and S.O.Moore.
Nuclear Sci. Engng (USA), Vol. 6, No. 6, 537-44 (Dec., 1959).

The breeding potential of thermal reactors is re-evaluated on the basis of present nuclear data. It is concluded that positive bree ing on the U^{233}—thorium cycle is possible with a variety of moderators including heavy water, graphite, beryllium, and ordinary water. Current measurements indicate that the accepted thermal value of $\eta_{23} = 2.28 \pm 0.02$ is somewhat conservative. Neutron spectrum considerations show that η_{23} decreases gradually with increasing reson ance absorption to a minimum of 2.14 ± 0.04. When neutron losses to the moderator are considered, maximum breeding gains of 0.26, 0.22, 0.21, and 0.19 respectively, are obtained for D_2O, graphite, Be, and H_2O moderated reactors. The breeding gain in reactors partially or completely moderated by beryllium can be considerably increased is use is made of the fast effect, presently estimated at 1.075 ± 0.02 for pure beryllium. Probable breeding gains in proposed full-scale fluid fuel breeders are estimated at 0.09 for the Aqueous Homogeneous Reactor and 0.05 for the graphite moderated Liquid Metal Fuel Reactor and Molten Salt Reactor. Breeding in predominantly thermal, solid fuel reactors also appears within reac if neutron losses are minimized. The possibility of positive breeding in near thermal, plutonium fuelled reactors is unsettled although this goal can be approached by maximum use of the fast effect in U^{238}. Estimates of breeding ratios in plutonium fuelled reactors depends on the variation of η_{49} with neutron temperature which is still inadequately known.

758 AUTOCORRELATION FUNCTIONS OF COUNTING RAT IN NUCLEAR REACTORS. C.Vélez.

Nuclear Sci. Engng (USA), Vol. 6, No. 5, 414-19 (Nov., 1959).

The general form of the autocorrelation function of the counting rate in a nuclear reactor is established. The autocorrelation function is computed in two examples and the expressions thus obtained are compared with the results of experiments.

759 NUCLEAR REACTOR KINETICS SIMULATOR.

W.Filipczak and M.Sztajnkoler.
Nukleonika (Poland), Vol. 4, No. 4, 395-404 (1959). In Polish.

The kinetic equations may be solved in real time or in time expanded by a factor of 5. A potentiometer varies the effective multiplication factor over the range from -10% to +1% δk. A type MDM operational amplifier is used with a gain of 3×10^6, including the phase-inverter loop. A d.c. amplifier with a gain 1800 is used as the phase inverter. The simulator is operated over 3 decades from 0.05 to 50 V.

760 METHODS OF CHOOSING THE CHARACTERISTICS OF A MATERIALS TESTING REACTOR. W.Frankowsk

Nukleonika (Poland), Vol. 4, No. 5, 491-504 (1959). In Polish.

The essential data are reviewed and related to materials testin reactors already operating. The minimum requirements are stated to be met by the Polish materials testing reactor which will be working during 1965-80 (maximum neutron flux $3\text{-}4 \times 10^{14}$ neutrons $cm^{-2}\ sec^{-1}$).

761 ANALOGUE COMPUTERS IN REACTOR ENGINEERING AND THE SIMULATOR AT THE CZECHOSLOVAK INSTITUTE OF NUCLEAR PHYSICS.

M.Krejči, M.Melichar and M.Zikán.
Nukleonika (Poland), Vol. 4, No. 5, 505-21 (1959). In Polish.

762 A GENERAL PROPERTY OF BOUNDEDNESS FOR THE POWER OF SOME STABLE AND UNSTABLE NUCLEAR REACTORS. H.B.Smets.

Nukleonik (Germany), Vol. 2, No. 2, 44-5 (April, 1960).

If the reactivity k of a nuclear reactor is a linear function of the power n:

$$k = -\int_0^\infty K(u)\,[n(t-u)-n_0]\,du,$$

it is shown that the power remains bounded for all initial conditions when the kernel K(u) is non-negative. The value of the upper bound of the power is derived in the case of fast transients.

763 ION CURRENT CHAMBERS USED IN THE CONTROL O NUCLEAR REACTORS. W.Dąbek.

Nukleonika (Poland), Vol. 4, No. 5, 523-46 (1959). In Polish.

The principles of the operation, design, technology and the mos important parameters of neutron-sensitive ionization chambers are discussed. A number of conditions which a chamber must fulfill are given. The possibility is discussed of extending the range of the neutron flux which can be measured in the presence of a high-gamma radiation background.

764 THE INFLUENCE OF THE GEOMETRIC SYMMETRIES OF A HETEROGENEOUS REACTOR ON THE FLUX DISTRIBUTION. L.Dresner

Nukleonik (Germany), Vol. 2, No. 2, 45-7 (April, 1960).

In a bare, homogeneous reactor, the space and energy dependences of the flux are separable under quite general assumptions. This theorem is extended to some heterogeneous reactors. It is found that for certain heterogeneous reactors of special shape and geometric symmetry, there are eight networks of points each with the following properties: (1) The space and energy dependence of the flux is separable at these points; the spectrum is thus the same at all points of a network; (2) The space dependence of the flux over a network is the same as that of the flux in a homogeneous reactor lying inside the same boundary.

765 STABILITY OF A CONTINUOUS-MEDIUM REACTOR. W.K.Ergen and J.A.Nohel.

Reactor Science (GB), Vol. 10, No. 1-2, 14-18 (July, 1959).

Sufficient conditions for the stability of a continuous-medium reactor are given under the assumptions that there is no mechanical vibration coupled with the oscillation of reactor power; the delayed-neutron effects may be neglected; and that hydrodynamic flow does not affect dynamic stability. The conditions given involve only known reactor parameters, and numerical examples are considered to complement the theory.

766 NEUTRON LIFETIME MEASUREMENTS IN THE FAST REACTORS ZEUS AND ZEPHYR.

G.Ingram, D.B.McCulloch and J.E.Sanders.

Reactor Science (GB), Vol. 10, No. 1-2, 22-31 (July, 1959).

Measurements of the mean prompt neutron lifetime have been made by a perturbation technique, by the use of a reactivity oscillator, and by the Rossi-α method in which the time correlation of fission chamber pulses is studied. The lifetime in Zeus was found to be 7×10^{-8} sec and in the graphite reflected version of Zephyr, 5×10^{-6} sec.

767 REACTOR KINETICS FOR MULTI-REGION MULTI-FUEL REACTORS.

H.L.Garabedian and P.von Herrmann.

Reactor Science (GB), Vol. 10, No. 1-2, 36-43 (July, 1959).

On the basis of two group diffusion theory the inhour and kinetic equations are derived for a reactor containing a different fissionable material in each of its two regions. The method of small perturbations is used in the derivation. The results are compared with inhour and kinetic equations that would be obtained by homogenizing the materials from both regions throughout the reactor. Methods for computing the parameters occurring in the equations are indicated.

768 COMPOSITE REACTOR LATTICES. A.N.Buckler and C.Carter.

Reactor Science (GB), Vol. 10, No. 1-2, 44-52 (July, 1959).

A procedure is presented for the homogenization of a large heterogeneous reactor consisting of a composite lattice of several different types of fuel rod immersed in a moderator. The properties of the composite lattice are expressed as suitable averages of the properties of single lattices containing only one type of fuel rod.

769 THE CONCEPT OF COMPLEX RELAXATION TIME IN REACTOR DYNAMICS. L.Gold.

Reactor Science (GB), Vol. 10, No. 1-2, 53 (July, 1959).

The kinetic equations for a reactor are written in terms of the prompt and an average delayed group of neutrons with characteristic relaxation times. Complex relaxation times can occur in the solution of these equations and these can be used to account for instabilities indentified with sustained pile oscillations. J.F.Hill

770 THE EFFECT OF NEUTRON TEMPERATURE ON CHARGE LIFE AND CONVERSION RATIO IN A HIGH POWER REACTOR. A.K.Krasin, M.E.Minashin and V.Ya.Sviridenko.

Atomnaya Energiya (USSR), Vol. 5, No. 2, 111-18 (1958). In Russian. English translation in: Reactor Science (GB), Vol. 10, No. 1-2, 56-74 (July, 1959).

Results are presented of some calculations on the effect of the neutron temperature on the reactor operating period, Pu^{239} breeding ratio, and the amount of electrical power generated, for two uranium—graphite sodium-cooled reactor cores. In one version, the fuel elements were sheathed in zirconium, in another they were sheathed in steel. The overall economic optimum neutron temperature was found to lie in the range 900-1000°K. Similar calculations were also made for two other types of reactor: a homogeneous sodium—graphite reactor and a heterogeneous uranium—graphite gas-cooled reactor. Graphs illustrating the results of these calculations are given.

771 A MEASUREMENT OF THE NEUTRON SPECTRUM IN THE THERMAL COLUMN OF THE POWER-STATION REACTOR. A.P.Senchenkov and F.M.Kuznetsov.

Atomnaya Energiya (USSR), Vol. 5, No. 2, 124-9 (1958). In Russian. English translation in: Reactor Science (GB), Vol. 10, No. 1-2, 75-9 (July, 1959).

A high-transmission mechanical neutron-velocity selector suitable for spectrum measurements in the energy range below 0.5 eV is described, and the results are given of a determination with this selector of the neutron spectrum in the thermal column of the power-station reactor. Kinks are found in the spectrum at velocities of 600, 1000 and 1650 $msec^{-1}$, and their causes are analysed. The inelastic scattering cross-section of graphite is estimated. By least squares fitting of a Maxwell distribution the neutron temperature is shown to be 345°K for a graphite temperature of 304°K.

772 TRANSIENT TEMPERATURES IN A URANIUM ROD. C.S.Lowthian.

Reactor Science (GB), Vol. 10, No. 3-4, 95-103 (Sept., 1959).

The equation for the temperature distribution in a uranium rod under transient conditions is subjected to the finite Hankel transform, to produce a formal relationship between the physical parameters of rate of heat production, rate of heat removal and the temperature at any point in the rod. The form of solution is then applied to find the changes in uranium surface and centre temperatures following arbitrary changes in the rates of heat production and heat removal. The method is an inverse one in that arbitrary forms are assumed for a function $\phi(t)$ which is introduced into the equations, and the resulting variations of uranium temperature and rates of heat production and removal are examined. Within this limitation, however, the temperature and reactivity changes within the reactor can be determined for a short period of time following a disturbance, during which the relatively small thermal capacity of the uranium makes it the dominating variable.

TRANSIENT TEMPERATURES IN A URANIUM ROD.
See Abstr. 772

773 ANALYTIC SOLUTIONS FOR TRANSIENT TEMPERATURE DISTRIBUTIONS IN TWO-REGION NUCLEAR REACTOR FUEL ELEMENTS. F.Narin and D.Langford.

Nuclear Sci. Engng (USA), Vol. 6, No. 5, 386-90 (Nov., 1959).

Analytic solutions are developed for the transient temperature distributions in two-region nuclear reactor fuel elements. One region contains a space-independent heat source having an arbitrary time dependence; the other region is source-free. Infinite cylinder and infinite slab geometries are considered, and simplifying assumptions are discussed which reduce the general solutions to simple forms of special interest in reactor safety studies.

774 A METHOD FOR THE CALCULATION OF THE THERMAL UTILIZATION IN THE HETEROGENEOUS REACTOR. A.Kirchenmayer.

Atomkernenergie (Germany), Vol. 4, No. 10, 395-7 (Oct., 1959). In German.

A method which simplifies this calculation is given. It is shown that the absorption and the increase of the neutron flux in a hollow cylinder can be simply expressed by the neutron currents crossing the envelopes and by two groups of Bessel functions. Approximate formulae are also given. This method leads to the following: only two groups of Bessel functions appear in the expression for thermal utilization; the absorptions of the single media are obtained directly; the derivation is shorter. For other geometries, the situation is similar.

775 THE THERMAL UTILIZATION OF THE HETEROGENEOUS REACTOR IN TERMS OF THE TWO-GROUP THEORY. A.Kirchenmayer.

Atomkernenergie (Germany), Vol. 4, No. 10, 397-8 (Oct., 1959). In German.

The thermal utilization f is derived for a cylindrical cell in which the slowing down is taking place only in the moderator whereby the distribution of the fast and thermal neutrons is assumed to be according to the two-group theory. The result is given as a function of the usual thermal utilization f_0 which results from the assumption that the slowing down density is the same at all points in the moderator. The small difference between f and f_0, which is of the order 10^{-4}, confirms the former assumption and establishes its accuracy at least according to the two-group theory.

776 ON THE CALCULATION OF THE THERMAL UTILIZATION. M.Angelopoulos.

Atomkernenergie (Germany), Vol. 4, No. 11, 437-42 (Nov., 1959). In German.

For the calculation of the thermal utilization factor of a lattice cell with a bare fuel element, a knowledge of the "disadvantage factor", $\bar{\phi}_1/\bar{\phi}_0$, is essential. The original calculations of the neutron flux distribution in a cell, and hence of the disadvantage factor, were carried out on the assumption that diffusion theory could be applied both in the fuel rod and the moderator, the following approximations being made: (a) the lattice cell is replaced by a cylindrical cell having the same area of cross-section; (b) there is no change of flux along the length of the cell; (c) there is no net current across the cell boundary; (d) the rate of production of thermal neutrons is constant throughout the moderator; (e) the thermal neutron flux across the air channel is conserved and the total neutron current leaving the moderator at the moderator-channel interface is equal to the absorption in the fuel element. The boundary condition (e) does not, however, account for the shadowing caused by the fuel rod; that is, the rod intercepts some neutrons which leave the moderator and causes the flux at the air—moderator interface to be higher than that at the air—fuel interface. A modification to the diffusion theory of the thermal fine structure to include the effect of air channels was given by Newmarch (1955). He found that the ratio of the fluxes at the two boundaries of the air channel was independent of the moderator properties and the pitch. A basically different approach has been developed by Amouyal, Benoist, and Horowitz (1957). Instead of using diffusion theory, it is based on probability considerations. The formula for the disadvantage factor involves two probabilities; first, that of escape from the fuel rod, and secondly, that of escape from the moderator. The region within the moderator—channel interface is supposed to be black, and the neutrons are assumed to be produced uniformly and isotropically within the moderator, and to satisfy the reflection condition at the outer perimeter of the cell. The derived formula for f is comparable in simplicity to that given by elementary diffusion theory. Stuart (1957-8) has presented a multiple collision method based on transport theory for the calculation of the flux distribution within an absorbing medium. This method has been applied in the present paper to the region within the fuel element, elementary diffusion theory being used only within the moderator. Calculations are carried out for a number of natural uranium rod and air channel diameters, at two pitches. The results, together with those from Newmarch's and Amouyal's method using the same data, are compared with experimental measurements.

777 CALCULATION OF TEMPERATURE AND MECHANICAL STRESS IN [REACTOR] SHIELDING.

E.Schröder.

Atomkernenergie (Germany), Vol. 4, No. 11, 442-5 (Nov., 1959). In German.

Due to thermal neutron capture energy is released in form of gamma-rays. These gammas are absorbed and produce heat. The temperature and stress distribution in shields caused by this process are discussed.

778 AN ITERATION METHOD FOR THE SPECIFICATION OF MULTIGROUP BUCKLINGS. A.Foderaro.

Nuclear Sci. Engng (USA), Vol. 6, No. 6, 514-24 (Dec., 1959).

A method is described for specifying the transverse leakage (buckling) in each energy group of a multigroup solution of the neutron transport equation. For two dimensional geometry a transverse buckling is associated with one direction and the resulting one-dimensional problem is solved; this gives the first estimate of the energy dependent buckling in the first direction. The next calculation uses this energy dependent buckling as the transverse buckling for a one-dimensional calculation in the other direction. As applied to a completely reflected finite cylindrical core, the method uses the core absorptions and leakages obtained from a one-dimensional multigroup calculation to predict the group bucklings to be used in the next iteration in the other direction. The process is repeated until the buckling in each group in each direction converges. The IBM-704 multigroup diffusion code GNU has been used in conjunctio with this buckling iteration method to compute the equivalent spheri al radii of a number of fully reflected finite cylindrical cores for which experimental data are available. The equivalent sphere diameters as calculated by the buckling iteration method deviate from the experimental diameters by an average of two percent over the range of core height to diameter ratios from $\frac{1}{3}$ to 5. The converged value of the multiplication constant was found to be independent of the initial guess made for the axial or radial buckling and insensitiv to the transverse bucklings assumed for the regions outside the cor for all except very small cores.

779 MATERIAL BUCKLING MEASUREMENTS IN A SUBCRITICAL ASSEMBLY. R.E.Uhrig.

Nuclear Sci. Engng (USA), Vol. 6, No. 6, 530-2 (Dec., 1959).

An alternate method of measuring material buckling in a subcritical assembly is presented. The fundamental mode of the neutron flux is isolated by using the orthogonality introduced when the equation for the neutron flux in a subcritical assembly is multiplied by $[\cos(\pi x/a)\cos(\pi y/b)dx\ dy]$ and integrated over the cross-sectional area of the assembly. The resulting double integral is evaluated by measuring the neutron flux at grid points and then employing tabular integration. After neutron flux measurements have been taken on two levels, the inverse relaxation length and material buckling can be evaluated. The precision of these determinations are obtained by using the method of propagation of precision indices.

780 CALCULATION OF FAST-NEUTRON MULTIPLICATION IN THICK FUEL ELEMENTS. K.O.Thielheim.

Atomkernenergie (Germany), Vol. 4, No. 11, 429-37 (Nov., 1959). In German.

A method is presented for calculating fast neutron multiplication in thick fuel elements. Both (1) change of collision probability in succeeding neutron collision generations and (2) degradation of neutron energy by inelastic scattering are considered. In thin fuel elements (1) and (2) have generally no influence on neutron multiplication. Collision probabilities in plane and spherical geometry were evaluated numerically on an IBM 704 digital computer and are presented. The influence of inelastic scattering is determined by the method of "neutron classes" which are defined according to the multiplicity of inelastic scattering. Results of this method show that energy degradation by inelastic scattering may have a nonnegligible effect on fast neutron multiplication in thick fuel elements. Comparison is made between methods neglecting (2)-variational method, diffusion approximation, transport theory - showing the feasibility of the transport theoretical method.

781 THERMAL STRESSES IN REACTOR SHELLS DUE TO THERMAL NEUTRON IRRADIATION. II. M.J.Hillier.

Reactor Science (GB), Vol. 10, No. 3-4, 104-10 (Sept., 1959).

Assuming that the γ-ray source in a flat plate may be expressed in a one-dimensional representation by the sum of exponential terms, the rate of heat production, peak plate temperature and stress are calculated by methods described in Pt I, (Abstr. 767 of 1960). The results are presented in the form of dimensionless curves so as to apply to a wide range of materials and the calculations may be related to the heating of a plate due to a thermal neutr distribution of the form

$$\Sigma[\phi_n \exp(Kx) + \phi_n \exp(-Kx)].$$

782 MIGRATION AREAS AND EFFECTIVE DELAYED NEUTRON FRACTIONS BY CRITICAL EXPERIMENTS.

G.A.Price.

Reactor Science (GB), Vol. 10, No. 3-4, 111-15 (Sept., 1959).

Migration areas and effective delayed neutron fractions were measured in critical assemblies of slightly enriched uranium rods in light water. The fuel consists of uranium rods, enriched to 1.3% U^{235}, 4 ft long 0.387 in.diameter and clad in aluminium. Water to uranium volume ratios of 2 : 1, 3 : 1 and 4 : 1 were investigated. Migration areas were measured by observing the effect of fuel rod changes and boron poison in the water, separately and combined, on the excess reactivity. The analysis yields a value of M^2 which depends on the delayed neutron parameters, and one which is independent of them. Values of M^2 obtained by these methods are compared with those obtained earlier by sub-critical methods. A value of the effective delayed neutron fraction, $\gamma\beta$, in the assemblie is derived from the effect of uniform boron poison on the reactor periods. An average value of 0.0069 ± 0.0001 is obtained for the three assemblies.

783 DISTRIBUTION OF RESONANT NEUTRON CAPTURE IN A NATURAL URANIUM ROD—APPLICATION TO
RX ROD 683. S.A.Kushneriuk.
eactor Science (GB), Vol. 10, No. 3-4, 133-40 (Sept., 1959).

A calculation of the neutron resonance escape probability and
e radial distribution of resonant neutron capture in a natural
ranium rod in the NRX reactor is presented. The calculation uses
NL-325 (Hughes and Harvey, 1955) cross-section data for radiative
eutron capture in U^{238} and extrapolates these data by methods
erived from the general theory of nuclear reactions into the energy
egions in which the BNL-325 information is incomplete. The reson-
ce escape probability so calculated agrees well with the value ob-
ined from the semi-empirical formula. Theoretical values of the
verage capture cross-section in U^{238} in the neutron energy range
300 to 1.2×10^4 eV are also given.

784 ACCURACY AND SCOPE OF VARIATIONAL AND • DIFFERENCE SOLUTIONS OF THE DIFFUSION
QUATIONS OF REACTOR THEORY. R.T.Ackroyd and M.A.Perks.
eactor Science (GB), Vol. 10, No. 34, 141-6 (Sept., 1959).

A comparison is made of the accuracy of variational and
ifference solutions of the one-group diffusion equation. For reactors
ith a few regions there is little practical difference in the solutions
r the fluxes and Laplacians as given by the two methods. The
ariational method can easily be used with a hand machine, and when
rogrammed for a digital computer it is several times faster than the difference method. The authors' experience with a medium size computer is that the variational method is the more accurate for reactors with many regions.

785 FISSION FRAGMENT IMPACT TRAPPING BY ThO_2 SLURRY PARTICLES. D.G.Gardner.
Nuclear Sci. Engng (USA), Vol. 6, No. 6, 487-92 (Dec., 1959).

Assuming a uniform distribution of ThO_2 slurry particles suspended in an aqueous medium, the probability of a recoil fission fragment escaping the parent slurry particle then coming to rest within another slurry particle has been estimated. The results indicate that for the slurry particle diameters and volume concentrations that may be expected in certain homogeneous reactor systems only a small percentage of the fission fragments will end their range within slurry particles. The theoretical predictions compare favourably with experimental results from a U-O aqueous slurry system.

786 REACTIVITY ASSOCIATED WITH THE DECAY OF Np^{239} IN IRRADIATED NATURAL URANIUM DIOXIDE.
S.B.Gunst.
Nuclear Sci. Engng (USA), Vol. 6, No. 5, 376-8 (Nov., 1959).

In the calculation of irradiation-induced changes in reactivity in natural uranium, the direct formation of Pu^{239} upon neutron capture in U^{238} is frequently assumed. The attendant error in reactivity during irradiation is shown to be significant for an illustrative case even after high exposure. This suggests that the consequences should be examined when the direct formation of Pu^{239} is assumed.

ATOMIC AND MOLECULAR PHYSICS

ATOMS

787 SURVEY OF ATOMIC CONSTANTS.
J.A.Bearden and J.S.Thomsen.
uovo Cimento Suppl. (Italy), Vol. 6, No. 1, 141-5 (1957).

Summary of part of work reported in Abstr. 9837 of 1957.

J.Hawgood

788 AN EXTENSION OF STATISTICAL ATOMIC MODELS BY THE INCLUSION OF A CORRELATION CORRECTION.
.Gombás.
nn. Phys. (Germany), Vol. 7, No. 1-2, 1-7 (1960). In German.

A simplification of Lewis' procedure (Abstr. 3952 of 1959) is
sed to yield an expression for the Thomas—Fermi—Dirac statistical
tomic model. Solutions of this relation are given for many atoms
nd ions and values calculated for correlation energies.

W.J.Orville-Thomas

789 VARIATIONAL METHOD FOR THE SOLUTION OF THE QUANTUM-MECHANICAL MANY-BODY PROBLEM.
.Ladányi.
cta phys. Hungar., Vol. 9, No. 1-2, 115-24 (1958).

Gives a generalization of the variational method of Macke for
e problem of atomic electrons in a spherical symmetric outer
otential. For a large number of particles in a slowly changing
otential this becomes a generalization of the statistical method
ased on grouping the particles by their azimuthal quantum number.
or a small number of particles, various approximations are made.
he calculated energy of the argon atom agrees with Slater's semi-
mpirical value within 5%.

J.Goldstone

790 ON THE EIGENVALUES AND EIGENFUNCTIONS OF THE SCHRÖDINGER EQUATION FOR THE THOMAS—FERMI
OTENTIAL. T.Tietz.
cta phys. Hungar. Vol. 11, No. 4, 391-400 (1960). In German.

A method applicable to free neutral atoms is given, and some
umerical results are compared with those of Hartree and Latter.

791 THE RELATION BETWEEN LÖWDIN'S SPIN PROJECTION OPERATOR AND PRATT'S SPIN OPERATOR.
.Berencz.
cta phys. Hungar., Vol. 12, No. 1, 47-53 (1960).

Löwdin (Abstr. 4385 of 1960) has given a spin projection operator, which selects a state of multiplicity $(2l + 1)$ when operating on a Slater determinant. Pratt (Abstr. 1538 of 1960) has also derived an operator, which creates a state of definite multiplicity, when operating on a Slater determinant. It was verified that, for constructing singlets the two operators are identical, except for a constant factor.

792 THOMAS—FERMI TECHNIQUE FOR DETERMINING WAVE FUNCTIONS FOR ALKALI ATOMS WITH EXCITED VALENCE ELECTRONS. H.J.Brudner and S.Borowitz.
Phys. Rev. (USA), Vol. 120, No. 6, 2053-63 (Dec. 15, 1960).

A technique has been developed for the calculation of excited state, one-electron wave-functions based on the Thomas—Fermi statistical theory of the atom. This technique is applied to heavy alkali atoms for which Hartree-type solutions are complex and difficult to obtain. The Thomas—Fermi differential system for the alkali positive ions is accurately solved utilizing Milne's method, and the results are summarized. This Thomas—Fermi core potential is then used as a central field in the Schrödinger equation, together with the Heisenberg type of polarization energy correction. Angular dependence is assumed to be capable of separation, and two basic techniques for solving the radial Schrödinger equation are discussed, one due to Ridley, the other to Biermann and Lübeck type solution also allows for the inclusion of a qualitative correction for exchange. The techniques are applied to the potassium atom with an excited valence electron in the 6s state. The results are encouraging when compared with a Biermann and Lübeck type calculation using a Hartree central potential done by Villars. The 7s state of the caesium atom which has not been obtained by Hartree central potential is also computed.

793 APPROXIMATE BINDING ENERGIES OF INNER ELECTRONS IN ATOMS BY THE WKB METHOD.
T.Tsang.
Physica (Netherlands), Vol. 25, No. 12, 1241-3 (Dec., 1959).

Near the nucleus, the effective nuclear charge is approximately a parabolic function of the radius. Based on the W.K.B.method, modified by Langer using a least square parabolic fit of the Thomas—Fermi potential, the approximate binding energies of inner electrons may be expressed as a function of the atomic number, principal and orbital quantum numbers. Comparison with results using the more precise Hartree method indicates that the accuracy of this method is comparable to that of the numerical calculations by Latter (Abstr. 8169 of 1955) using the Thomas—Fermi potential directly.

794

CALCULATION OF THE CORRELATION ENERGY OF ATOMIC ELECTRONS.

L.Szász.

Z. Naturforsch. (Germany), Vol. 152A, No. 10, 909-26 (Oct., 1960). In German.

To calculate the correlation energy of an atom with N electrons the following wave-function is suggested

$$\psi = \frac{1}{\sqrt{N!}} \tilde{A}\left\{\varphi_1(1)\,\varphi_2(2)\ldots\varphi_N(N)\left[1+\sum_{j=1}^{N}\ \sum_{k=j+1}^{N} W_{jk}(j,k)\right]\right\}, \qquad \text{(a)}$$

where A is the antisymmetrizer operator, $\varphi_1, \varphi_2, \ldots, \varphi_N$ are one-electron wave-functions, and W_{jk} are correlation functions of the following form:

$$W_{jk}(1,2) = \sum_{m,n,l} c_{jk}^{m,n,l}\,(r_1 - r_2)^{2m}(r_1 + r_2)^{n}\,r_{12}{}^{l}, \qquad \text{(b)}$$

where the constants $c_{jk}^{m,n,l}$ are variational parameters. The function (a) is a generalization of the wave-function of Hylleraas for He. After a discussion of the properties of function (a), an energy expression is derived. Numerical calculation is made for the ground state of the Be atom with the function

$$\psi_{Be} = \frac{1}{\sqrt{4!}} \tilde{A}\{\varphi_1(r_1)\,\varphi_2(r_2)\,\varphi_3(r_3)\,\varphi_4(r_4)\,[1 + c_1 r_{12} + c_2 r_{34}]\}, \qquad \text{(c)}$$

where φ_1 and φ_2 are 1s wave-functions, φ_3 and φ_4 are 2s wave-functions, r_1, r_2, r_3 and r_4 are the radial coordinates of the four electrons, r_{12} and r_{34} are the distances between the corresponding electrons, and c_1 and c_2 are variational parameters. Using the one-electron wave-functions calculated by Roothaan et al. with the Roothaan procedure, one obtained the energy value E = −14.624 a.u. while the Hartree—Fock and experimental values are $E_{H,F}$ = −14.570 a.u. and E_{exp} = −14.668 a.u., respectively. Thus the function (c) gives about one-half of the correlation energy of the Be atom.

795

ANTISHIELDING AND CONTRACTED WAVE FUNCTIONS.

G.Burns and E.G.Wikner.

Phys. Rev. (USA), Vol. 121, No. 1, 155-8 (Jan. 1, 1961).

The antishielding factors, γ_∞ of several contracted negative ions are calculated and compared to the apparent experimental values. Although the use of contracted wave-functions results in considerably smaller γ_∞'s, the agreement is still not encouraging for the negative ions. Interrelations are found among the wave-functions contracted by different means. Also, γ_∞ of several closed-shell positive ions and two ^6S state ions (Mn^{2+} and Fe^{3+}) are calculated so that information from measured quadrupole coupling constants can be obtained. These positive-ion results with other published values should enable γ_∞ of all closed-shell ions to be estimated. The results are used to determine the nuclear quadrupole moment of Fe^{57m} from the published value of the quadrupole coupling constant in Fe_2O_3. This result is discussed.

796

ON THE EFFECT OF A NUCLEAR ELECTRIC DIPOLE MOMENT ON THE ENERGY LEVELS OF AN ATOM IN A UNIFORM ELECTRIC FIELD.

J.P.Barrat.

J. Phys. Radium (France), Vol. 20, No. 8-9, 765-6 (Aug.-Sept., 1959). In French.

It is shown that, if spin—orbit interaction is neglected, the linear Stark effect due to a nuclear dipole moment is exactly cancelled by an equal and opposite effect due to the dipole moment induced in the electron atmosphere. The method used is similar to that of Abstr. 3726 of 1959. J.Hawgood

UNRESTRICTED HARTREE—FOCK METHOD: ELECTRON DENSITIES AND MAGNETIC FORM FACTORS FOR SPIN POLARIZED Ni^{++}. See Abstr. 20769 of 1960.

797

PROGRESS OF RADIOMETRIC OBSERVATION OF INFRARED ATOMIC EMISSION SPECTRA.

C.J.Humphreys.

J. Opt. Soc. Amer., Vol. 50, No. 12, 1171-5 (Dec., 1960).

The radiometric observation of infrared atomic spectra during the past half-century may be divided into three periods. During the first, relatively short period of point-by-point observation, associated with Paschen, the thermal detector and astatic galvanometer were brought to a high state of perfection. The infrared spectra of alkalis and alkaline earths were explored in this manner. The following 35 years were unproductive in this field of research. A few excellent investigations took advantage of improved devices such as the thermal relay and automatic recording. During the 10 years of the modern period, photoconductive detectors have been incorporated into scanning spectrometers to permit high-resolution observations in the region beyond the limit of photographic respons An account of new work since 1956 is given. The status of infrared observations is summarized and completely referenced. An accoun of current programmes for establishment of standards is included.

798

NEGATIVE ABSORPTION IN METAL VAPOURS.

S.G.Rautian and I.I.Sobelman.

Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 1(7), 217-19 (July, 1960) In Russian.

The authors consider a mixture of two gases, a resonance leve of one lies near to excited levels of the second. An example is found in which mixed sodium and mercury vapours are illuminated by the mercury line λ = 2537 A. It is estimated that the maximum concentration of sodium in the 8^2P level is $\sim 3 \times 10^9$ cm^{-3} and it is suggested that the transitions 8^2P-8^2S or 8^2P-7^2S are the most promising for amplification by stimulated emission. [English trans lation in: Soviet Physics—JETP (USA)]. M.G.Priestle

799

THE INTERPRETATION OF COMPLEX SPECTRA.

L.Bovey.

Research (GB), Vol. 13, No. 11, 428-35 (Nov., 1960).

A summary is made both of the atomic designations (multiplicity S, orbital L and total J angular momenta) needed to characterize energy levels which give rise to atomic spectra and how these are used to give information on the electronic configurations involved. The methods used to derive such information from experimental investigations of wavelengths, Zeeman effect, hyperfine and isotope structure are described. The relative positions of the lanthanide and actinide series in the periodic table are discussed from a spectroscopic view point.

SCEPTRE III — AN INTENSE SOURCE OF THE SPECTRA OF HIGHLY IONIZED ATOMS. See Abstr. 235

800

"REPULSION OF ENERGY LEVELS" IN COMPLEX ATOMIC SPECTRA.

N.Rosenzweig and C.E.Porter.

Phys. Rev. (USA), Vol. 120, No. 5, 1698-1714 (Dec. 1, 1960).

It is shown that "repulsion of energy levels" of the same symmetry type occurs in complex atomic spectra. Thus, for the elements Hf, Ta, W, Re, Os, and Ir, for which the spin-dependent forces are relatively strong, the spacings between neighbouring odd-parity levels of the same J value follow the Wigner distributio (approximately). For the elements Sc, Ti, V, Cr, Mn, Fe, Co, and Ni, for which the spin-dependent forces are relatively weak, a similar distribution is obtained for the odd-parity levels having fixed values for S, L, and J. (When the quantum numbers S and L are disregarded, the same levels give rise to a distribution of spa ings which is approximated by a random superposition of a number of appropriately weighted Wigner distributions). For the elements Y, Zr, Nb, Mo, Ru, Rh, and Pd, for which the spin-dependent force are of intermediate strength, the empirical distribution of spacing between the odd levels of the same J value has a character which i intermediate between the Wigner and exponential distributions. Al of these observations are explained in terms of a statistical model for the Hamiltonian matrix in the S, L, J, π representation. Quant tive results are obtained for a relatively simple form of the model which depends on only two parameters, viz., the dimensionality N and the ratio μ of the dispersions of the normal distributions for t off-diagonal and diagonal matrix elements. The transition from th exponential to the Wigner distribution occurs, roughly speaking, in the range of $N\mu^2$ from 0 to 1. The results of this work suggest th an empirical study of the distribution of the spacing between the energy levels of a complex quantum system may be capable of poin ting to the existence of constants of the motion beyond those which are already known.

801

THEORY OF THE HYPERFINE ANOMALIES OF DEUTERIUM, TRITIUM, AND HELIUM-3^+.

D.A.Greenberg and H.M.Foley.

Phys. Rev. (USA), Vol. 120, No. 5, 1684-97 (Dec. 1, 1960).

The covariant equation for the three-body deuterium system i discussed, and reduced to a three-dimensional equation for the cas of instantaneous two-body interactions. A noncovariant perturbation scheme, based on this three-dimensional equation, was emplo to calculate the hyperfine structure (h.f.s.) to order $\alpha m/M$ (h.f.s.) for $_1H^2$, $_1H^3$, $_2He^{3+}$. The results are compared with the experime values, and shown to be compatible. Final determination of the the

tical values and the adequacy of the theory is shown to depend cri-
cally on the determination of a number of experimental quantities,
particular on a more precise measurement of α, of the nucleon
ectric and magnetic form factors and associated nucleon polariza-
on, of the presence and magnitude of a two-nucleon spin-orbit poten-
al, and of the singlet n—p effective range.

802 OPTICAL RESONANCE AND SELECTIVE REFLECTION WITH CADMIUM AND ZINC VAPOURS.

I.Spitzer.
nn. Phys. (France), Ser. 13, Vol. 5, No. 5-6, 707-67 (May-June,
960). In French.

Wavelengths 2139 A (Zn) and 2288 A (Cd) correspond to the
lly allowed transition ${}^1S_0$-${}^1P_1$ (as for the Hg line 1849 A); measu-
ements of the polarization of the resonance scattered radiation,
ade photographically with a Wollaston prism indicate a lifetime
r the excited state of 4.3 × 10^{-10} sec for Zn, whereas the calculated
alue is 2.0 × 10^{-9} sec. For the not fully allowed transition
$_0$-${}^3P_1$ at 3261 A for Cd, the polarisation is complete for irradia-
on along the direction of an applied magnetic field in the case of
d^{114} with zero nuclear spin while other isotopes show a polariza-
on of 0.44; both these results are expected. For Cd 2288 A selec-
ve reflection by the vapour is found to increase with pressure up
2 atmospheres.

G.F.Lothian

803 HYPERFINE STRUCTURE IN THE GROUND STATE OF THE STABLE ISOTOPES OF EUROPIUM.

.G.H.Sandars and G.K.Woodgate.
roc. Roy. Soc. A (GB), Vol. 257, 269-76 (Sept. 6, 1960).

The hyperfine structure of the ground state $4f^76s^2\ {}^8S_{7/2}$ of Eu^{151}
nd Eu^{153} was measured by the method of magnetic resonance in
atomic beam. The sign of the hyperfine structure and the value
g_j were also measured. The results are: $g_j = 1.9935 \pm 0.0003$;
(151) = −20.0523 ± 0.0002 Mc/s, A(153) = −8.9532 ± 0.0002 Mc/s,
(151) = −0.7012 ± 0.0035 Mc/s, B(153) = −1.7852 ± 0.0035 Mc/s;
(151)/A(153) = 2.26498 ± 0.00008, B(151)/B(153) = 0.393 ± 0.003.
he results disagree with the values expected for the pure ${}^8S_{7/2}$
ate formed from a half-filled shell of f-electrons. Calculations
the basis of admixture of higher states of the configuration by
oin—orbit coupling account for the discrepancy in g_j, but do not
xplain the values of the hyperfine structure constants A and B.
urther theoretical work is in progress. See also following
bstract

804 THE NUCLEAR MAGNETIC DIPOLE MOMENTS OF THE STABLE ISOTOPES OF EUROPIUM AND THE YPERFINE STRUCTURE ANOMALY.

.M.Pichanick, P.G.H.Sandars and G.K.Woodgate.
roc. Roy. Soc. A (GB), Vol. 257, 277-82 (Sept. 6, 1960).

The nuclear magnetic dipole moment of Eu^{151} and the ratio of
e moments of Eu^{151} and Eu153 were measured by the new method
resonance in three loops in a short atomic beam. The results
e: $\mu(\mathrm{Eu}^{151}) = 3.419 \pm 0.004$ n.m.; $\mu(\mathrm{Eu}^{151})/\mu(\mathrm{Eu}^{153}) = 2.2686 \pm 0.0015$.
he result, taken together with the ratio of the hyperfine structures
europium gives a hyperfine structure anomaly of (1.0 ± 0.23)
theoretical value of the anomaly is estimated. See also preceding
stract.

805 THE LAMB SHIFT OF HELIUM.

A.Dalgarno and A.L.Stewart.
roc. Phys. Soc. (GB), Vol. 76, Pt 1, 49-55 (July, 1960).

Using carefully selected oscillator strengths, the logarithm of
e average excitation energy, measured in rydbergs, appropriate
the Lamb shift was computed to be 4.37 ± 0.03. Taken together
ith recent calculations by Pekeris (1959), the theoretical value of
e ionization potential of helium was 198310.674 ± 0.025 cm^{-1}
ompared with $198310.8_2 \pm 0.15$ cm^{-1} the experimental value.

LIGHT EMISSION BY HYDROGEN IONS. See Abstr. 20646 of
960.

806 THE CONFIGURATIONS $3d^n4p$ IN THE SECOND SPECTRA OF THE IRON GROUP. G.Racah and N.Spector.

ull. Res. Coun. Israel, Vol. 9F, No. 2, 75-92 (Nov., 1960).

The experimental terms of the $3d^n4p$ configurations of the
econd spectra of the iron group are compared with the results of
eoretical calculations. Interpolation formulae are given for the
teraction parameters.

807 INFLUENCE OF TEMPERATURE ON THE PRESSURE BROADENING OF THE MERCURY RESONANCE LINE.

T.Skaliński.
Bull. Acad. Polon. Sci. Ser. Sci. math. astron. phys. (Poland), Vol. 8, No. 2, 119-23 (1960).

Contrary to existing theories of pressure broadening, it was found that the value of the total absorption remained essentially unchanged in the temperature range from 320° to 1250° K.

P.M.Parker

808 THE FORMATION OF WEAKLY BOUND MOLECULES. MERCURY-INERT GAS AND THEIR CONTRIBUTION TO THE SATELLITE BANDS OF THE MERCURY 2537 Å(${}^1S_0 - {}^3P_1$) RESONANCE LINE PERTURBED BY INERT GASES AT LOW DENSITIES.

A.Michels, H.de Kluiver and C.A.Ten Seldam.
Physica (Netherlands), Vol. 25, No. 12, 1321-57 (Dec., 1959).

An attempt was made to describe the violet side bands occurring in the 2537 A (${}^1S_0$-${}^3P_1$) mercury resonance line perturbed by inert gases, measured in absorption in terms of weakly bound molecules Hg-inert gas. The contribution of free pairs Hg—A and Hg—Kr to the formation of the red wing (as was suggested by Kuhn) was investigated by a classical approximative method. The contribution of weakly bound molecules Hg-inert gas was also considered. For this purpose the rotation—vibration spectrum for Hg—A in the electronic ground state was calculated, based on the potential as given by Heller (1941). For low densities of the perturber an expression was derived for the number density of weakly bound molecules Hg-inert gas; the partition over the vibrational states was derived. For a temperature of 325°K and argon density of 1 amagat, the fraction of the mercury atoms in bound states was calculated to be 0.673%. For helium and krypton calculations of a more approximate character were carried out. For a restricted density range the fraction of bound mercury atoms is approximately proportional to the density of the inert gas. This together with the calculated results for the heavier inert gases (argon and krypton) indicate that at not too low densities the contribution of these molecules to the integrated absorption coefficient may be considerable. The variation in the intensity of the satellites as a function of inert gas density and temperature as measured was found to be compatible with a description in terms of weakly bound molecules. For the unknown potential, $V'(r)$, which describes the interaction between an excited mercury atom and an inert gas atom in the normal state a plausible model was taken. With this model it was possible to describe the violet wings of the outer satellites (S II of Hg—A and S III of Hg—Kr) as a result of transitions from the lowest vibrational level, $v'' = 0$, of the electronic ground state to the repulsive part of the upper potential $V'(r)$. This description runs along similar lines to those first given by Winans and Stueckelberg (1928) for the continuous bands of H_2. With a more refined treatment as regards the shape of the violet wing of the Hg—A satellite S II, it is found possible to determine the parameters occurring in $V'(r)$ so as to obtain agreement between the experimental and the theoretically predicted shapes. The increase of the absolute value of the absorption coefficient in the top of S II was approximately calculated as a function of the argon density. In this calculation the value of the potential $V'(r)$, found for the description of the satellite shape, was substituted; a satisfactory agreement with the experimental result was obtained.

809 THE OSCILLATOR STRENGTHS AND THE TRANSITION PROBABILITIES OF THE FIRST SHARP SERIES DOUBLET LINES OF INDIUM. Shang-Yi Ch'en and A.Smith.

Physica (Netherlands), Vol. 25, No. 12, 1289-93 (Dec., 1959).

The oscillator strengths and the transition probabilities of the first sharp series doublet (5p – 6s) lines of indium (λλ 4511 and 4101) were determined from the extrapolations to zero foreign gas pressure of the plots between the integrated line absorption and the relative densities of foreign gases. The f-values turned out to be 0.1000 and 0.0959 for the two components respectively and the transition probabilities are respectively 5.93 × 10^8 and 5.39 × 10^8. Helium pressures produced no observable effect on the integrated line contours, while the increase of argon pressure caused profound increase in absorption. Due to uncertainties in the concentration of absorbing atoms under various pressures of foreign gases, it is unreliable to associate the observed increase in the integrated line absorption with the increase of f-values of the lines concerned.

810

MUTUAL MAGNETIC INTERACTIONS AND OSCILLATOR STRENGTHS IN THE FIRST SPECTRUM OF OXYGEN.

R.H.Garstang.

Proc. Cambridge Phil. Soc. (GB), Vol. 57, Pt 1, 115-20 (Jan., 1961).

The effects of the spin–other-orbit and spin–spin interactions on the energy levels of the $2p^3$ 3s configuration of oxygen are investigated, and they are found to make an appreciable contribution to the fine structure. The interactions are shown to have a negligible effect on the strengths of all the stronger lines of the $2p^4$-$2p^3$ 3s array, and the more important of the weaker transitions are likewise little affected. The value to be adopted for the radial integral involved in the absolute oscillator strengths is discussed, and numerical values of the oscillator strengths are given.

811

THE HYPERFINE STRUCTURE OF SOME URANIUM AND AMERICIUM LINES IN THE 1.6 - 2.1 MICRON REGION.

R.Beer and L.Bovey.

Proc. Phys. Soc. (GB), Vol. 76, Pt 4, 569-74 (Oct. 1, 1960).

A combination of intense microwave-excited sources, a grating spectrometer and a high-pressure scanning Fabry–Perot interferometer allowed a study (at a resolution of approximately 250 000) for about twelve lines. Isotope shifts for U^{235}, U^{236}, and U^{238}, and magnetic hyperfine structures for Am^{241} were found together with some less definite results for plutonium.

812

DERIVATION OF SAUTER'S FORMULA FOR THE PHOTOELECTRIC EFFECT BY MEANS OF BORN'S APPROXIMATION METHOD.

M.Gavrilă.

Stud. cercetari Fiz. (Roumania), Vol. 8, No. 4, 421-32 (1957).
In Roumanian.

Sauter's formula for the photoelectric effect scattering cross-section actually corresponds to retaining the first Born approximation for the final electronic state spinor. As shown, the direct use of Born's approximation method not only greatly simplifies the deduction of the formula, but also provides a method for treating the higher order corrections. The matrix element M of the process is given in momentum space. The sum over the spin directions is reduced to the use of standard formulae. Owing to a peculiarity of the photoelectric effect, Sauter's formula, though estimated by means of spinors, correct to the second order in αZ, represents only the zeroth order approximation to the exact scattering cross-section.

813

ELECTRON–HYDROGEN ATOM SCATTERING IN BORN APPROXIMATION.

T.Y.Wu.

Canad. J. Phys., Vol. 38, No. 12, 1654-60 (Dec., 1960).

The elastic (1s - 1s) and the inelastic (1s - 2s, 1s - 2p) scattering cross sections in the Born approximation at energies of 1, 4, 9, 16 rydbergs have been calculated exactly from the closed formulas of the matrix elements for these transitions. Both the differential and the total cross sections are given here.

814

BORN CROSS SECTIONS FOR INELASTIC SCATTERING OF ELECTRONS BY HYDROGEN ATOMS. III. 5s, 5p, 5d, 5f, 5g STATES.

S.N.Milford, J.J.Morrissey and J.H.Scanlon.

Phys. Rev. (USA), Vol. 120, No. 5, 1715-17 (Dec. 1, 1960).

For Pt I and II, see Abstr. 13403-4 of 1960. Born total cross-sections are computed for the strong optically allowed transitions from n = 5 to n' = 6, at incident energies between 0.2 and 1361 eV. Thirty energy values are considered for the 5s to 6p and 5g to 6h cases, and nine for the other transitions. The cross-sections obtained are larger than those of comparable transitions for lower n. The Bethe (dipole) approximation is also used, and is found to give good agreement with the Born results down to relatively low energies (~3 eV).

815

THE ELASTIC AND INELASTIC SCATTERING OF ELECTRONS AND POSITRONS FROM THE S-STATES OF ATOMIC HYDROGEN.

K.Smith, W.F.Miller and A.J.P.Mumford.

Proc. Phys. Soc. (GB), Vol. 76, Pt 4, 559-64 (Oct. 1, 1960).

Total elastic and inelastic cross-sections, for the scattering of electrons (without exchange) and positrons (neglecting the formation of positronium) from the 1s, 2s and 3s state of atomic hydrogen, were calculated in three approximations using the method of partial waves. All significant partial wave contributions to the cross-sections were included. The results indicate that "s-state" distortion effects are negligible at incident energies greater than 30 eV.

816

RELATIVISTIC K-SHELL STOPPING POWER THEORY.

H.S.Perlman.

Proc. Phys. Soc. (GB), Vol. 76, Pt 3, 433-6 (Sept. 1, 1960).

The contribution of the K-shell to the stopping power of mercur for relativistic electrons is calculated, using Dirac wave-functions and the Møller interaction. The results are compared with those of approximately relativistic calculations.

817

THE INTERACTION OF DIFFERENTLY EXCITED LIKE ATOMS AT LARGE DISTANCES.

R.S.Mulliken.

Phys. Rev. (USA), Vol. 120, No. 5, 1674-84 (Dec. 1, 1960).

The theory of long-range first-order interaction energies is discussed for two like odd-electron atoms in different doublet states, for the case that spin-orbit coupling is smaller than the other splittings. The treatment involves some revision and some extension of previous work. At interatomic distances sufficiently large that overlap of the wave-functions of the two atoms is negligible, only the first-order dispersion (dipole–dipole and higher multipole) forces remain, but it is shown that even at rather large distances there often is sufficient overlap that valence forces predominate over first-order dispersion forces. For the case of two H atoms, one in a ^2S and the other in a ^2P state, it is shown that the first-order dispersion energy corresponds explicitly to a particular e^2/r_{12} integral which represents precisely the mutual electrostatic energy, falling off approximately as $1/R^3$, of two dipolar charge distributions one on each atom. (All the other valence-force e^2/r_{12} integrals fall off exponentially with R). Tables are given for the first-order dispersion splitting patterns (out to terms in $1/R^3$) for the interaction of a ^2P with a ^2S or with a ^2D atom Finally, the first-order splittings for pairs of like even-electron atoms is discussed. The results are simpler than for odd-electron atoms, and are applicable also to any pair of such atoms either in singlet states or in any states in which spin-orbit coupling is strong For atoms both in, for example, triplet, states with weak spin-orbit coupling, different formulae will be needed.

818

ION–ATOM POTENTIAL ENERGY FUNCTIONS OBTAINED FROM keV SCATTERING DATA.

G.H.Lane and E.Everhart.

Phys. Rev. (USA), Vol. 120, No. 6, 2064-9 (Dec. 15, 1960).

The potential energy functions between ions and atoms in collision were determined from experimental data. The ion–atom combinations studied include A^+ on A, Ne^+ on A, Ne^+ on Ne, He^+ on A, He^+ on Ne, and He^+ on He, using differential cross-section measurements by Fuls et al. (Abstr. 8687 of 1960) and Jones et al. (Abstr. 4752 of 1959), made at 25, 50, and 100 keV. These data are analysed using equations developed by Firsov (Abstr. 8548 of 1954). The potential energies are positive, are in the range of one to sixty thousand electron volts, and correspond to ion–atom separations of a small fraction of an angstrom. The resultant potential energy curves are compared with a function derived by Firsov from a statistical model and they are found to fit fairly well. The fit to an exponentially screened Coulomb potential energy curve is not quite as good, but both these theoretical curves fall within the accuracy of the experimental data.

819

INTERATOMIC REPULSIVE POTENTIALS AT VERY SMALL AND INTERMEDIATE SEPARATIONS.

A.A.Abrahamson, R.D.Hatcher and G.H.Vineyard.

Phys. Rev. (USA), Vol. 121, No. 1, 159-71 (Jan. 1, 1961).

Using a minimal and a maximal principle, respectively, two approximate expressions for the interaction potential between atom are given such that their mean $\bar{U}(R)$, differs from the exact value, U_0, in the Thomas–Fermi–Dirac approximation, but not more than 4% for the case of two-centre system; and by not more than 14%, in the Thomas–Fermi approximation, for the case of a three-centre system. The respective limits of applicability of these potentials are discussed, and some of their applications are pointed out.

820

OBSERVATION OF QUANTUM EFFECTS IN THE SCATTERING OF A MONOENERGETIC Li BEAM BY A CROSSED Hg BEAM.

H.U.Hostettler and R.B.Bernstein.

Phys. Rev. Letters (USA), Vol. 5, No. 7, 318-20 (Oct. 1, 1960).

A velocity-selected lithium beam was scattered by a crossed beam of mercury at 90° incidence. Data on total and differential cross-sections are presented which are believed to show De Brogli interference effects. These effects were predicted by Massey and Mohr (Abstr. 3940 of 1933; 1461 of 1934) but have not been hitherto observed in atomic-beam scattering by gases. P.M.Parke

POLARIZATION AND FOCUSING OF ATOMIC BEAMS BY
IPOLE FIELDS. See Abstr. 886

sotopes

821 THE ENRICHMENT OF WATER IN H_2O^{18} BY LIQUID THERMAL DIFFUSION. G.S.Panson and P.B.Sullivan.

. phys. Chem. (USA), Vol. 64, No. 6, 825-6 (June, 1960).

Water of normal isotopic composition (containing approximately part in 500 of H_2O^{18}) was enriched in H_2O^{18} by thermal diffusion in e liquid phase employing a column similar to that used for $_2$O-D_2O mixtures. After 168 hours the R value at the bottom of the olumn was 1.0328, as compared with an arbitrary 1.0000 at the eginning. As the magnitude of the enrichment decreases with ncreasing H_2O^{18} concentration, the employment of this method for rge-scale separation is not justified. A.Avraam

MOLECULES

539.19

822 A DISCUSSION ON THE EFFECT OF ENVIRONMENT UPON MOLECULAR ENERGY LEVELS.

roc. Roy. Soc. A (GB), Vol. 255, No. 1280, 1-81 (March, 1960).

A discussion at which ten papers were presented. It is concerned ith an enquiry into the nature and operation of intermolecular forces order to try and interpret the various interactions in terms of appropriate energy levels and to correlate them with the electronic structures f interacting species. From the extremely varied collection of phenomena resented there emerge many important criteria which clarify the somehat chaotic position which has previously existed in this field and also iggest the most promising lines of future work. The interactions disissed consist of the dipole—dipole, induced dipole and quadrupole effects, pin decoupling and repulsion overlap, field effects and ion-pair perturbaons. Progress is reported in the interpretation of the shifts in the lectronic spectra due to a solvent perturber and evidence is given at the changes in the frequency, band intensity and width of a vibraonal chromophore are due to specific dipolar interactions rather an the bulk dielectric effect of the solvent medium alone. Infrared d nuclear magnetic resonance data seem to suggest how the specic interactions operate and in the case of solid matrices it is ported how differently sized ions can perturb the ions of a dissolved olute. Theoretical approaches to the problems are also given otably the extension of the dielectric field theory. R.A.Ballinger

823 THE USE OF THE HELLMANN—FEYNMAN THEOREM TO CALCULATE MOLECULAR ENERGIES.

.F.W.Bader.

anad. J. Chem., Vol. 38, No. 11, 2117-27 (Nov., 1960).

The Hellmann—Feynman theorem was employed to calculate e repulsion between two helium atoms and the molecular energies f H_2 and H_3. The method of molecular orbitals was used to determine the necessary expressions for the electron densities. The creening constant of the atomic orbitals comprising the molecular rbitals were treated as functions of the internuclear separation ccording to an empirical expression which duplicates very closely e "best" values for these parameters as determined by the variaonal method. The results of the calculations indicate that the resent method is capable of yielding estimates of molecular nergies which are comparable to those obtained by the more laborate and time-consuming variational methods.

824 INVARIANCE OF MOLECULAR "INVERSE" FORCE-CONSTANTS. S.J.Cyvin and N.B.Slater.

ature (GB), Vol, 188, 485 (Nov. 5, 1960).

The numerical values of force constants depend upon the oordinates chosen to define the vibrating system. "Inverse" force onstants are defined which do not depend upon the choice of ternal or symmetry coordinates. W.J.Orville-Thomas

825 POTENTIAL FUNCTIONS OF MOLECULES OF THE HOMOLOGOUS SERIES $(CH_3)_n SiH_{4-n} (n = 1 - 4)$.

.Kovalev.

okl. Akad. Nauk SSSR, Vol. 134, No. 3, 559-62 (Sept. 21, 1960).

Russian.

Frequencies, normal modes of vibrations, force constants and e sensitivities of the frequencies to variations of these coefficients were calculated in earlier papers [Optika i Spektrosk, Vol. 4, 560 (1958); Vol. 6, 594 (1959)] for these Si-organic compounds; in the present paper the interaction coefficients are calculated in the natural coordinate system based on the diagram of the equilibirum configuration of the $(CH_3)_3SiH$ molecule, the system of the interaction coefficients being calculated by the method of determinants. Several general conclusions relating to potential functions, and the characteristic, valency and deformation frequencies are drawn from the analysis of the present and earlier results. F.Lachman

826 NOTE ON THE DETERMINATION OF THE POTENTIAL FUNCTIONS OF POLYATOMIC MOLECULES.

D.M.Dennison.

J. Opt. Soc. Amer., Vol. 50, No. 12, 1267-70 (Dec., 1960).

It is shown that first-order changes in the normal modes of vibration of a polyatomic molecule do not alter the normal frequencies except in second or higher order. This fact provides a convenient method of obtaining the best fit between the observed and calculated frequencies by adjusting the potential constants and also of ascertaining the relative importance of each constant in its effect on the spectrum. It further emphasizes, however, the well-known difficulties in obtaining reliable potential functions and shows that very considerable errors may occur in the determination of the potential and of the normal modes.

827 EFFECT OF THE BASIC STRENGTH OF ATTACHED GROUPS ON LIGHT ABSORPTION SPECTRA.

IV. PROTON DISSOCIATIONS OF SOME AROMATIC MOLECULES IN THEIR EXCITED STATE. R.Itoh.

J. Phys. Soc. Japan, Vol. 14, No. 9, 1224-31 (Sept., 1959).

For Pt III, see Abstr. 8387 of 1958. A general standard of classification is given for the acid-base character of some aromatic molecules with special reference to the change of character after and before the first excitation. The criterion is $\Delta q \gtreqqless 0$, Δq being the change in the π-electron density of the special member of the attached group after and before the excitation. This corresponds to $pK_{\alpha_1} \lesseqqgtr pK_{\alpha_2}$, where pK_{α_1} and pK_{α_2} are the proton dissociation constants in the ground and the excited state, respectively. Examples are the case of acridon cation which gives $\Delta q = 0.099$ corresponding to $pK_{\alpha_2} - pK_{\alpha_1} = 2.48$ (observed value 2.6) and the case of 3-oxyacridine which gives $\Delta q = -0.18$ corresponding to $pK_{\alpha_2} - pK_{\alpha_1} = -4.52$ (observed value, if any, -5.27). The cases of naphthylamine and naphthol, treated in Pt III, are discussed and some corrections concerning the term values given.

828 REPULSIVE POTENTIAL BETWEEN NONBONDED METHYL GROUPS. J.Overend and J.R.Scherer.

J. Opt. Soc. Amer., Vol. 50, No. 12, 1203-7 (Dec., 1960).

The vibrational analysis of many molecules depends critically on being able to supply values for some of the force constants. In particular, for many chemically interesting molecules it is important to know the repulsive force constants between two methyl groups bonded to the same atom, and the known frequencies of tetramethyl carbon, silicon, germanium, tin, and lead have been used to determine this force constant as a function of the carbon—carbon internuclear distance. Results indicate that $F_{CC} = \partial^2 V(r_{CC})/\partial(r_{CC})^2 = 196.5\, r_{CC}^{-6.8}$ md. A.

829 MEASUREMENTS ON HIGHER J ROTATIONAL LINES OF VIBRATION ROTATION BANDS AND STUDY OF RESONANCES IN LINEAR POLYATOMIC MOLECULES. I. ν_2 AND $2\nu_2{}^0$ BANDS OF $HC^{12}N$.

W.W.Brim, J.M.Hoffman, H.H.Nielsen and K.Narahari Rao.

J. Opt. Soc. Amer., Vol. 50, No. 12, 1208-13 (Dec., 1960).

The $\nu_2{}^0$ bands of the $HC^{12}N$ molecule have been measured with a vacuum grating spectrometer and the molecular constants evaluated. Observations on the ν_2 band have been carried out to J = 40 and the data did not reveal any necessity for introducing an H term in the expression for the rotational term value. The anomalous centrifugal distortion constant observed for the $2\nu_2{}^0$ band has been discussed in the light of current theories. The difference bands $3\nu_2{}^1 - \nu_2{}^{1(c)}$ and $3\nu_2{}^1 - \nu_2{}^{1(d)}$ have been identified in the region of absorption of the $2\nu_2{}^0$ band.

830 INTERNAL ANGULAR MOMENTUM IN HINDERED ROTATION. D.G.Burkhard.

J. Opt. Soc. Amer., Vol. 50, No. 12, 1214-27 (Dec., 1960).

When describing the motion of two rigid molecular groups which are undergoing mutual rotation with respect to each other about a definite axis and which are at the same time rotating freely in space, there are several ways in which one may fix the coordinate axes which translate with the centre of mass of the body. Origin of the axes is placed at the over-all centre of mass in order to separate the translational and rotational parts of the Hamiltonian. There still remains a choice in the determination of the orientation of these axes with respect to the two groups. The axes may be fixed in one of the groups or they may have a variable orientation with respect to the two groups. The initial part of this paper is restricted to a discussion of axes in a configuration consisting of a completely asymmetric molecule with an attached symmetric group rotating about the symmetry axis of the symmetric group. Some remarks are made regarding a choice of axes for two internally rotating asymmetric groups.

831 EXPERIMENTAL TRANSMISSION FUNCTIONS FOR THE PURE ROTATION BAND OF WATER VAPOR.

C.H.Palmer, Jr.

J. Opt. Soc. Amer., Vol. 50, No. 12, 1232-42 (Dec., 1960).

Experimental transmission data are given for mixtures of water vapour and nitrogen for the 20 to 50 μ region of the pure rotation band of water vapour. These data yield a set of transmission functions for 50 cm^{-1} intervals in agreement with a theoretical curve of Benedict. Average transmission is plotted as a function of the parameter $U = WP^*$, in which W is the vapour optical path in precipitable centimetres and P^* an effective pressure. This effective pressure is the sum of the total pressure and the water vapour partial pressure multiplied by a variable self-broadening factor. For meteorological purposes the self-broadening may be omitted. The set of transmission functions in turn yields a generalized absorption coefficient for the region.

832 VIBRATION—ROTATION BANDS OF N_2O.

E.D.Tidwell, E.K.Plyler and W.S.Benedict.

J. Opt. Soc. Amer., Vol. 50, No. 12, 1243-63 (Dec., 1960).

The spectrum of nitrous oxide has been measured with a high-resolution grating spectrometer in the region from 2395 to 3510 cm^{-1}. Long absorbing paths were used in a heated cell, so that it was possible to observe many of the weaker bands, including those with lower vibrational levels ν_2, $2\nu_2^0$, $2\nu_2^2$, and ν_1. Accurate values of the rotational constants have been obtained, including the l-type doubling and variations with ν and l of the centrifugal stretching constant. These have been correlated with other data to obtain improved values of the molecular constants, with particular attention to the Fermi interaction. Other weak interactions are observed and discussed.

833 VIBRATION SPECTRA OF SOME TIN (IV AND II) FLUORINE COMPLEXES.

H.Kriegsmann and G.Kessler.

Naturwissenschaften (Germany), Vol. 47, No. 17, 393-4 (1960). In German.

The Raman and infrared vibration frequencies are reported for a number of compounds of Sn and F. Some force constants are calculated. The spectra indicate the existence of the ions $(SnF_3)^-$ and $(SnF_6)^{2-}$. G.F.Lothian

834 FIRST EXCITED $^1\Sigma_g^+$ STATE OF H_2. A DOUBLE MINIMUM PROBLEM.

E.R.Davidson.

J. chem. Phys. (USA), Vol. 33, No. 5, 1577 (Nov., 1960).

As a preliminary to a complete theoretical analysis of the H_2 spectrum, the potential curve for a first excited state has been calculated using a twenty term expansion together with the excited state variation theorem. The curve is found to have a double minimum and comparison of this and of calculated vibrational levels is made with experiment. R.A.Ballinger

835 INVESTIGATION OF THE EXCITED STATES OF THE H_2-MOLECULE BY MEANS OF THE UNITED ATOM MODEL.

I.Tamássy-Lentei.

Acta phys. Hungar, Vol. 12, No. 2, 119-29 (1960).

For the singly excited states of types 1sσ nlλ computations were made for the cases nlλ = 2sσ, 2pσ, 2pπ, 3sσ, 3pσ, 3pπ, 3dσ, 3dπ, 3dδ, 4sσ, 4pσ, 4pπ, 4dσ, 4dπ, 4dδ, 4fσ, 4fπ, 5pπ, 5dσ, 5fσ, 6pπ, with hydrogen-like one-electron wave-functions centred on the central point of the molecule. If one takes the wave-function of the electron 1sσ as a linear combination of the functions 1s, 2s, 3d, the results obtained for the energy agree fairly well with the experimental values.

836 INVESTIGATION OF THE $A^3\Pi$ STATE OF THE NH MOLECULE.

I.Kovács.

Acta Phys. Hungar., Vol. 12, No. 1, 67-76 (1960).

The multiplet splittings observed in the $A^3\Pi$ state which, as a function of the rotational quantum number, deviate from the term formulae derived on the basis of Van Vleck's theory, can be interpreted as the perturbation of the $^3\Pi$ state by the $^1\Pi$ state, as well as taking into account simultaneously the spin—spin interaction.

837 PRECISE MEASUREMENT OF THE MICROWAVE ABSORPTION FREQUENCIES OF THE OXYGEN MOLECULE AND THE VELOCITY OF LIGHT.

R.W.Zimmerer and M.Mizushima.

Phys. Rev. (USA), Vol. 121, No. 1, 152-5 (Jan. 1, 1961).

Ten microwave absorption frequencies of the oxygen molecule in the 60 kMc/s region were measured with an accuracy of about 10 kc/s. The result is interpreted by successfully refining the existing theory. Comparing the resultant value of the rotational constant B_0 with the value obtained in ultraviolet spectra, the velocity of light is calculated to be 299 773 ± 12 km/sec.

838 MICROWAVE SPECTRUM OF ETHYL IODIDE.

T.Kasuya and T.Oka.

J. Phys. Soc. Japan, Vol. 14, No. 7, 980-1 (July, 1959).

Some 70 lines are assigned in the range 5-30 Gc/s. The rotational constants (in Mc/s) are: $A = 29\,109.2 \pm 5$; $B = 2\,979.2 \pm 0.5$; $C = 2\,797.1 \pm 0.5$. An analysis of the nuclear quadrupole coupling of the iodine is made. Some lines for which $K_{-1} = 1$ show small further splittings due to hindered internal rotation of the methyl group, and a height for the hindering barrier of 2.4 kcal/mole is derived. This is some 30% lower than the barriers in ethyl chloride and bromide (Abstr. 3299 of 1959). J.Sherida

839 THE MICROWAVE SPECTRUM OF METHYL CYANIDE AND 1-TYPE DOUBLING IN CH_3CN, CH_3NC, CH_3CCH AND CF_3CCH.

T.S.Jaseja.

Proc. Indian Acad. Sci. A, Vol. 50, No. 2, 108-28 (Aug., 1959).

The spectrum was obtained corresponding to the transitions $J = 0 \rightarrow 1$, $J = 1 \rightarrow 2$, and $J = 2 \rightarrow 3$ in the ground vibrational state a well as in the excited degenerate vibrational states $\nu_8 = 1$ and $\nu_8 = 2$ The frequencies of the lines were measured using a secondary standard spectrograph taking ammonia lines as standards. The value of the vibration—rotation interaction constant α_8 was found to be -27.3 ± 0.4 Mc/s. The spectrum obtained for the transitions $J = 1 \rightarrow 2$ and $J = 2 \rightarrow 3$ with $\nu_8 = 1$ was explained on the basis of Nielsen's theory of l-type doubling in symmetric top molecules. T assignments give a value of 0.94 for the Coriolis interaction consta which is consistent with the value obtained from infrared spectral data. Earlier work on similar transitions involving l-type doubling in the molecules CH_3NC, CH_3CCH and CF_3CCH is reviewed and the inconsistencies in the values of some parameters like Coriolis interaction constant ζ and the rotation constant D_{JK} obtained by earlier workers from their assignments are pointed out. A reassig ment of the transitions and the involved parameters removes these inconsistencies and yields Coriolis interaction constants which are in close agreement with those obtained from infrared spectral data The following are the different ζ values obtained:

$$\zeta_8 \text{ in } CH_3NC = 0.93$$
$$\zeta_{10} \text{ in } CH_3CCH = 1.00$$
$$\zeta_9 \text{ in } CH_3CCH = 0.95$$
$$\zeta_{10} \text{ in } CF_3CCH = 0.6$$

840 WIDE ABSORPTION BANDS IN THE INFRARED SPECTRA OF ADSORBED MOLECULES.

L.M.Roev.

Dokl. Akad. Nauk SSSR, Vol. 133, No. 3, 561-3 (July 21, 1960). In Russian.

See Roev and Terenin, Dokl. Akad. Nauk SSSR, Vol. 125, 588 (1959); Optika i Spektrosk. Vol. 7, 756 (1959), and Terenin and Roev Spectrochim. Acta, Vol. 15, 274, 946 (1959). The transparency of adsorbents (e.g. silica gel) depends to a large extent on the vapour pressure of the adsorbate in the cell, viz. it decreases as the vapou pressure increases and then attains a constant value. The decreas of transparency takes place in a wide region of infrared spectrum, which considerably exceeds the half-width of absorption bands of th adsorbed molecules. The adsorbents tested were MgO, SiO_2, Al_2O_3, Cr_2O_3, Fe_2O_3 and CaF_2, the adsorbates being H_2O, CCl_4, CHC CH_3CN, pyridine, nitrobenzene, cyclohexene, NH_3, CO, NO, CH_3OH, C_2H_5OH etc The nature and intensity of the "background" produce id its relationship to the pressure and boiling point of the adsorbate, s well as the temperature dependence point to the background being elated to the physical adsorption of molecules. F.Lachman

841
INTERFEROMETRIC SPECTRA OF AMMONIA AND CARBON MONOXIDE IN THE FAR INFRARED.

.Loewenstein.
. Opt. Soc. Amer., Vol. 50, No. 12, 1163-65 (Dec., 1960).

Spectra of NH_3, NH_2D and CO have been obtained interfero-
etrically, using the large lamellar grating interferometer at
ohns Hopkins University. The CO spectrum is used to illustrate
ie technique, and to show that some information may be obtained
irectly from the interferograms, without recourse to a numerical
ourier transformation. The spectrum of NH_3 shows pure rotation
nd inversion transitions in ν_2 vibrational fundamental.

842
PRECISE MEASUREMENTS OF SOME INFRARED BANDS OF HYDROGEN CHLORIDE.

).H.Rank, W.B.Birtley, D.P.Eastman, B.S.Rao and T.A.Wiggins.
. Opt. Soc. Amer., Vol. 50, No. 12, 1275-9 (Dec., 1960).

Precision determinations of the origins of the fundamental and
rst four harmonic bands of HCl^{35} have been made. The rotational
onstants of the 2-0 and 3-0 bands as well as the origin and rota-
onal constants of the 2-0 band of DCl^{35} are also reported. This
ork forms part of a study to determine rotation—vibration con-
tants for comparison with theoretical predictions.

843
INFRARED AND RAMAN SPECTRA OF SOME TIN-ALKYLS.

C.R.Dillard and J.R.Lawson.
. Opt. Soc. Amer., Vol. 50, No. 12, 1271-4 (Dec., 1960).

Infrared spectra in the wavelength region 2-25 μ of the series
: compounds, tetramethyltin, trimethylethyltin, dimethyldiethyltin,
iethyltriethyltin, and tetraethyltin, have been obtained as well as
aman data for tetramethyltin and tetraethyltin. The observed
pectra are interpreted on the basis of simple point group symmetry
ssuming that the alkyl radicals behave as "point masses".

844
HIGH RESOLUTION RAMAN SPECTROSCOPY OF GASES. XIII. ROTATIONAL SPECTRA AND STRUC-URES OF THE ZINC-, CADMIUM-, AND MERCURY-DIMETHYL IOLECULES.

K.Suryanarayana Rao, B.P.Stoicheff and R.Turner.
anad. J. Phys., Vol. 38, No. 11, 1516-25 (Nov., 1960).

For Pt XII, see Abstr. 7968 of 1959. The pure rotational spectra
: gaseous $Zn(CH_3)_2$, $Cd(CH_3)_2$, $Hg(CH_3)_2$, and of the fully deuterated
iolecules have been photographed with a 21 ft grating. The spectra
re typical of symmetric top molecules and consist of many evenly
paced rotational lines having a separation of about 0.45 cm^{-1}. An
ialysis of the spectra yielded the rotational constants (in cm^{-1})

$B_0[Zn(CH_3)_2] = 0.1348$ $B_0[Zn(CD_3)_2] = 0.1049$
$B_0[Cd(CH_3)_2] = 0.1140$ $B_0[Cd(CD_3)_2] = 0.0894$
$B_0[Hg(CH_3)_2] = 0{,}1162$ $B_0[Hg(CD_3)_2] = 0.0912.$

rom these constants the following metal—carbon bond lengths were
etermined: Zn—C = 1.929 A, Cd—C = 2.112 A, and Hg—C = 2.094 A.
elations for the C—H bond lengths and HCH angles were also
otained.

845
INFRARED BAND ASSIGNMENTS FOR THE 2900 cm^{-1} REGION METHYL GROUP VIBRATIONS IN $C_6H_4COOCH_3$, $XC_6H_4CH_3$, AND $XC_6H_4COCH_3$ MOLECULES.

.T.Forel, N.Fuson and M.L.Josien.
Opt. Soc. Amer., Vol. 50, No. 12, 1228-31 (Dec., 1960).

The spectra of monomethyl aromatic compounds in which the
ethyl group is attached either directly to the aromatic ring or to an
cygen or a carbonyl group carbon on a sidechain exhibit a 150 cm^{-1}
ide absorption region centering around 2920 cm^{-1}. This region
onsistently contains four bands, which have been assigned, in
ecreasing wave number order, to the following methyl group
brations: the totally asymmetric stretch; the axially asymmetric
retch which, however, preserves its symmetry with respect to the
olecule's symmetry plane; the totally symmetric stretch; and
cond harmonic of the asymmetric deformation. The exact position
this absorption region depends upon the point of attachment of the
ethyl group. Within certain series of homogolous molecules, such
the parasubstituted methyl benzoates, the position of the region is
so noticeably sensitive to the nature of the substituent.

846
RAMAN SPECTRUM OF MERCURIC CHLORIDE IN VARIOUS PHYSICAL STATES.

S.Brahms and J.P.Mathieu.
C.R. Acad. Sci. (France), Vol. 251, No. 7, 938-40 (Aug. 17, 1960).
In French.

The Raman spectrum of liquid $HgCl_2$ at 300° C and of the monocrystal confirms the linear symmetrical structure proposed for this molecule. G.I.W.Llewelyn

847
RAMAN SPECTRA OF POLYHALOGEN MOLECULES OBTAINED WITH A PLANE-GRATING SPECTROMETER.

M.Delhaye and M.B.Delhaye-Buisset.
J. Phys. Radium (France), Vol. 20, No. 6, 655-6 (June, 1959).
In French.

A modified spectrometer is described and some Raman bands of CCl_4, $SnCl_4$, BCl_3 and $BBrCl_2$ of high definition presented. G.I.W.Llewelyn

848
THE SECOND-ORDER RAMAN SPECTRUM OF TITANIUM TETRACHLORIDE.

B.Moszyńska.
Bull. Acad. Polon. Sci. Ser. Sci. math. astron. phys. (Poland), Vol. 7, No. 7, 455-9 (1959). In French.

Intensities, line-widths and line contours are determined photographically for $\nu_2 + \nu_3$, $2\nu_1$ and $\nu_1 + \nu_3$. Widths of combination lines are less than the sum of the component first-order lines. G.F.Lothian

849
EMISSION SPECTRUM OF THE B_2O_3 MOLECULE.

H.Grenat, L.Herman, R.Herman and S.Weniger.
Rev. Opt. (France), Vol. 38, No. 3, 134-7 (March, 1959). In French.

The authors succeeded in photographing the green light spectrum of a luminous gas flame saturated with boric oxide. The dispersion was sufficiently high to make visible the rotational structure of the individual branches. The complex structure is not explained.

850
LOWEST TRIPLET STATES OF ETHYLENE.

R.S.Mulliken.
J. chem. Phys.(USA), Vol. 33, No. 5, 1596-7 (Nov., 1960).

The 2000-2500 A bands in methylated ethylenes have vibrational intervals (about 1400 $\bar{\nu}$) which are too large for T ← N transitions. These intervals however agree well with the 1375 $\bar{\nu}$ spacing found in R←N bands. It is then highly probable that these bands have as their upper state the expected $^3B_{3u}$ state with the same electronic configuration as the $^1B_{3u}$ Rydberg state. This triplet Rydberg state is designated by the symbol T_R. T.E.Peacock

851
SPECTRAL EMISSIVITY OF HYDROGEN CHLORIDE FROM 1000-3400 cm^{-1}.

V.R.Stull and G.N.Plass.
J. Opt. Soc. Amer., Vol. 50, No. 12, 1279-85 (Dec., 1960).

The spectral emissivity of hydrogen chloride from 1000-3400 cm^{-1} is calculated as a function of temperature, pressure, and amount of radiating gas. The emissivity was calculated with the aid of an electronic computer from the usual expressions for the energy and intensity taking into account up to 2900 spectral lines at 2400° K. The harmonic oscillator approximation was used to evaluate the electric dipole matrix element for the higher vibrational states where no experimental measurements have been made. The emission from HCl^{35}, HCl^{37}, and DCl^{37} was included in the calculation. The statistical model and the random Elsasser model were used to calculate the emissivity from the line strengths. The characteristic shift of the emission to lower frequencies as the temperature increases is quantitatively explained. The emission in this frequency region of any flame containing HCl can readily be obtained from these results.

852
ULTRA-VIOLET ABSORPTION SPECTRA OF THE MOLECULES H_2O, HDO AND D_2O.

W.C.Price, P.V.Harris, G.H.Beaven and E.A.Johnson.
Nature (GB), Vol. 188, 45-6 (Oct. 1, 1960).

The spectrum of liquid water was determined with a vacuum grating spectrophotometer to 180 mμ, and does not show the fine structure reported by Golding [Nature (GB), Vol. 186, 308 (April 23, 1960)].

853
ROTATIONAL FINE STRUCTURE IN THE DIMER SPECTRUM OF HF.

W.F.Herget, N.M.Gailar, R.J.Lovell and A.H.Nielsen.
J. Opt. Soc. Amer., Vol. 50, No. 12, 1264-7 (Dec., 1960).

The regions of absorption recently reported by Smith (Abstr. 5940 of 1960) and ascribed to the HF dimer have been re-examined with a vacuum grating spectrometer. It has been observed that these regions resolve into fine structure. The results of this investigation are given.

854 ULTRA-VIOLET BANDS OF MERCURY IODIDE. V.G.Krishnamurthi.

Z. Phys. (Germany), Vol. 160, No. 4, 438-42 (1960).

The ultraviolet bands of mercury iodide were excited in an uncondensed discharge and photographed with a quartz Littrow spectrograph. The bands in the region 2658 to 2530 A were analysed into two systems which may form the two components of a $^2\Pi-^2\Sigma$ electronic transition with a $^2\Pi$ interval equal to 858.9 cm^{-1}. These systems and the systems in the region 3095 to 2647 A have the same lower state.

855 ABSORPTION SPECTRA IN THE FAR ULTRAVIOLET OF GASEOUS AND SOLID METHYL AND ETHYL IODIDE AND ETHYL BROMIDE. N.Astoin, J.Granier and M.Cordier.

J. Phys. Radium (France), Vol. 19, No. 4, 507-8 (April, 1958).
In French.

In the gas phase, the maxima of the continuous absorption bands occur at 39 000 cm^{-1} for CH_3I and C_2H_5I and at 49 000 cm^{-1} for C_2H_5Br. Narrow bands appear at higher frequencies. The first absorption peaks for the solids are displaced about 1000 cm^{-1} towards higher frequencies compared with those of the gases; a second continuous absorption region for the solids corresponds to the Rydberg series for the gases. J.Franks

856 THE ABSORPTION SPECTRUM OF THE FREE NCO RADICAL. R.N.Dixon.

Phil. Trans A (GB), Vol. 252, 165-92 (Jan. 28, 1960).

Two systems of absorption bands were observed in the visible and ultraviolet regions of the spectrum during the flash photolysis of several organic cyanates, and were photographed under high resolution with long absorbing paths. Extensive vibrational and rotational analyses were carried out for the bands of one system and show that the spectrum is due to an electronic transition $A(^2\Sigma^+) \leftarrow X(^2\Pi_i)$ of the free NCO radical, which is linear in both states. All three vibrational frequencies and the first-order anharmonic constants were obtained for the upper state, $A(^2\Sigma^+)$, and give a close fit to the term values of 21 observed vibrational levels. A Fermi resonance was observed between ν_1' and $2\nu_2'$. In addition, the rotational constants B' and D' and their variations with all three fundamental vibrations were obtained for this state. Transitions were observed from four excited levels of the bending vibration in the lower state, $X(^2\Pi_i)$, and the rotational constants were determined for some of these levels. Interaction between the electronic and vibrational motions (Renner effect) complicates the vibrational structure of this state. The state belongs to Hund's coupling case (a), and the spin—orbit coupling gives a splitting. $A'' = -95.6$ cm^{-1}. In a $^2\Sigma^+$ vibronic level of this state (arising from $l = 1$ and $\Lambda = 1$) the spin splitting is proportional to $N + \frac{1}{2}$, but the spin-splitting constant γ is unusually large, and amounts to 30% of the B value. The electronic states of NCO are correlated with those of its dissociation products. This shows that the bond dissociation energy of the CO bond is slightly greater than that of the CN bond in the three known states.

857 RECALCULATION OF THE MOLECULAR CONSTANTS OF $Ga^{69}Cl^{35}$. I.R.Bartky.

J. molecular Spectrosc. (USA), Vol. 5, No. 3, 206-9 (Sept., 1960).

The molecular constants obtainable from the ultraviolet spectroscopic measurements of Levin and Winans (Abstr. 182 of 1952) have been recalculated. The agreement between their work and the values obtained by microwave measurements has been substantially increased.

858 THE PRESENT-DAY STATE OF QUANTUM CHEMISTRY. H.Preuss.

Naturwissenschaften (Germany), Vol. 47, No. 11, 241-9 (1960).
In German.

The author reviews the aims and problems of quantum chemistry and its relation to practical chemistry. It is pointed out that semi-empirical methods such as those of Pauling have shown remarkable generality and agreement with experience, and a brief summary of these methods is given. A review is then given of the theory of chemical binding using theoretical procedures: (a) one electron Hamiltonian and effective potentials. (b) Neglect of electron interaction, included later as a perturbation. (c) Electron correlation. (d) Configuration interaction—determinantal wave-functions. (e) Hartree and Hartree—Fock wave-functions. Semi-theoretical (Pariser—Parr) methods are then reviewed. Their applications to π-electron systems are surveyed. The discussion of newer method concentrates on the "atoms in molecules" and "atom association" methods set out recently by the author (Abstr. 5108, 6181 of 1959). There is a discussion of natural spin orbitals and Hylleraas-type expansions in terms of Z. 31 refs. R.G.C.Arridg

859 THE RELATIVISTIC THEORY OF CHEMICAL BINDING K.S.Viswanathan.

Proc. Indian Acad. Sci. A, Vol. 50, No. 1, 1-18 (July, 1959).

Starting from Breit's relativistic equation for a system of two electrons, it is shown that for a hydrogen molecule (or for a system of two electrons moving in a field of cylindrical symmetry) the component of the total angular momentum (J_X) along the axis of the molecule (axis of symmetry) is a constant of motion. Thus every eigenstate of the system is simultaneously an eigenstate of J_X also, and a state of the system will specify, besides its energy, only the eigenvalue of the component of the angular momentum parallel to the axis of symmetry. The form of the four large components of the wave function relating to their dependence on the azimuthal co-ordinates is given. The case of Rusel—Saunders approximation is considered in detail and the nature of the components of the wave function for the singlet and triplet state is discussed. It is shown that the wave function for the ground state of the hydrogen molecule can be expressed as a sum of a set of symmetric function of which the first term is the Heitler—London function, and that the wave function for a triplet state should be a superposition of antisymmetric molecular orbitals. It is shown that relativistic theory brings about in a natural manner the facts relating to the ground state of the molecules C_2 and O_2. Finally, some remarks are made concerning the case of molecules for which the spin—orbit and the spin—spin coupling are strong.

860 A HALF-EMPIRICAL METHOD FOR THE DETERMINA-TION OF THE BOND ENERGY OF THE HYDROGEN MOLECULE'S GROUND STATE ON THE BASIS OF THE MOLECULAR ORBITAL METHOD. J.Ladik.

Acta phys. Hungar., Vol. 11, No. 4, 405-8 (1960).

861 DERIVATION OF APPROXIMATE TWO-ELECTRON ORBITALS. E.Kapuy.

Acta phys. Hungar., Vol. 11, No. 4, 409-15 (1960).

862 NOTE ON HURLEY'S "IMPROVED MOLECULAR ORBITALS AND THE VALENCE BOND THEORY". P.Phillipson and R.S.Mulliken.

J. chem. Phys. (USA), Vol. 33, No. 2, 615-16 (Aug., 1960).

An examination of Hurley's comment (Abstr. 17788 of 1960) on the behaviour, at large internuclear separations, of a wave-function used by the authors (Abstr. 8399 of 1958) for the lowest excited singlet and triplet states of H_2. The previous calculations are still valid for small and moderate nuclear separations. J.Sherida

863 THE MOLAR REFRACTION OF π-ELECTRONS OF SOME CONJUGATED MOLECULES. H.Sugier and W.Woźnicki.

Bull. Acad. Polon. Sci. Ser. Sci. math. astron. phys. (Poland), Vol. No. 2, 85-7 (1960).

The molar refraction of compounds containing conjugated doubl bonds is divided into two parts: a contribution from the σ-bonded core, and one from the π-electrons. With this model the π-electro refraction can be calculated using FEMO theory with an appropriat periodical potential to take into account the non-equivalence of the bonds. Good agreement between experimental and calculated value is obtained. W.J.Orville-Thoma

864 ON JAMES' TYPE OF WAVE FUNCTIONS FOR HYDROGEN MOLECULAR ION. Y.P.Varshni and R.C.Shukla.

Canad. J. Phys., Vol. 38, No. 11, 1547-51 (Nov., 1960).

A trial wave function, $a \exp(-b\xi).(1 + c\eta^2 + d\eta^4 + e\eta^6)$, where ξ and η are the confocal elliptic coordinates, gives little improvement over that with $d = e = 0$. J.Hawgoo

865 THE ELECTRONIC STRUCTURES OF SOME FIRST TRANSITION SERIES METAL PORPHYRINS AND PHTHALOCYANINES. J.S.Griffith.

Disc. Faraday Soc. (GB), No. 26, 81-6 (1958).

"Ions of the transition elements" Conference paper (see Abst 20727 of 1960). A theoretical discussion is given of electron reson nce and magnetic susceptibility measurements on copper, nickel, obalt and iron porphyrins and phthalocyanines. The experimental ata are consistent with the order for the 3d orbitals $3d_{xy} < 3d_{zx}$, $dyz < 3d_{x^2-y^2}$ and a variable position for $3d_{z^2}$, when the OX and OY xes are chosen so that they each pass through the metal nucleus nd two of its adjacent nitrogen nuclei.

866 THE INTERELECTRONIC REPULSION AND PARTLY COVALENT BONDING IN TRANSITION-GROUP OMPLEXES.

C.K.Jørgensen.

isc. Faraday Soc. (GB), No. 26, 110-15 (1958).

"Ions of the transition elements" Conference paper (see Abstr. 0727 of 1960). The ligand field theory expresses the energy levels a partly filled d-shell in complexes in terms of two types of para- eters: the orbital energy differences (in octahedral complexes Δ) d the integrals of interelectronic repulsion. The variation of Δ as function of the ligands for a given central ion is Tsuchida's pectrochemical series. Schåffer and Jǿrgensen established the ephelauxetic series, i.e. the decrease of interelectronic repulsion arameters relative to the gaseous ion, in many octahedral com- exes by application of Tanabe and Sugano's determinants. The stance $^6S-^4G$ in d^5-systems is discussed, because it is independent Δ to a very high approximation. The decrease of this distance an be ascribed to two effects: that the d-shell has the radial function xpanded due to the presence in the core of electrons donated from e ligands (central field covalency) and that the d-shell participates rectly in covalent bonding by forming linear combinations with the rbitals of the ligands (symmetry-restricted covalency). The pparent absence of effects of configuration intermixing is discussed.

867 ORBITAL MODIFICATION IN METAL COMPLEXES.

D.P.Craig and E.A.Magnusson.

isc. Faraday Soc. (GB), No. 26, 116-22 (1958).

"Ions of the transition elements" Conference paper (see Abstr. 0727 of 1960). The conditions under which atomic orbitals are ontracted or expanded by ligands are discussed. Under the in- uence of the negative charges of a ligand field 3d orbitals in the rst transition series are expanded, allowing the reduction in term pacings and Slater—Condon parameters in complexes to be partially, ven if not wholly, explained without electron transfer into the 3d rbitals. The effect of ligands on outer d orbitals is less than in olecules such as SF_6, but may lead to significant 4d covalent haracter in the metal-ligand bonds. Some consequences of outer d ovalent character are discussed.

868 THE INFLUENCE OF π-BONDING IN SOME TRANSITION METAL COMPLEXES.

R.J.P.Williams.

isc. Faraday Soc. (GB), No. 26, 123-30 (1958).

"Ions of the transition elements" Conference paper (see Abstr. 0727 of 1960). Current theories of the stability of complex ions f transition metal cations are described. It is shown that attempts correlate stabilities and the ligand (crystal) field splitting factor, (10 Dq), determined from spectra, cannot hold generally. The ariation in Δ from complex to complex is discussed noting both the ependence on ligand and on cation. The Δ values can be explained a dependence on the acceptor and donor character of the d orbitals both ground and excited states is assumed. It is concluded that the tabilities of complex ions should be referred only to the properties f the ground states and not to Δ.

869 THE TRANSMISSION OF ELECTRONIC EFFECTS THROUGH A HEAVY METAL ATOM.

Chatt, L.A.Duncanson, B.L.Shaw and L.M.Venanzi.

isc. Faraday Soc. (GB), No. 26, 131-7 (1958).

"Ions of the transition elements" Conference paper (see Abstr. 0727 of 1960). The transmission of electronic effects through a etal atom is investigated by examining the effect of different ligands certain hydrogenic vibrations in the infrared spectra of some atinum, palladium and rhodium complexes. It is concluded that the fects transmitted by uncharged ligands are mainly inductive in rigin. There are anomalies which can be interpreted as due to esomeric effects, and in some cases to the interaction of the -hydrogen atoms with the d-orbitals of the metal in primary and econdary amino-complexes and the amines. The effects transmitted om anionic ligands such as the halide tons are not fully understood d appear to be anomalous. The results are presented for discussion.

870 AMBIGUITY IN THE DETERMINATION OF SELF-CONSISTENT BOND ORDERS.

G.G.Hall.

J. chem. Phys. (USA), Vol. 33, No. 3, 953-4 (Sept., 1960).

The equations to determine bond orders for alternant hydrocarbons have many solutions and calculations have been made for trans-butadiene and benzene. Since the same equations are obtained for bond orders of certain excited states some doubt is raised as to the apparent uniqueness of iterative calculations using molecular orbital theory and the question of the stability of a molecule when some of its bonds are negative is raised. R.A.Ballinger

871 CALCULATIONS ON IONIC CHARACTER AND HYBRIDIZATION FROM DIPOLE MOMENTS FOR AsF_3 AND $AsCl_3$.

J.Sobhanadri.

Proc. Phys. Soc. (GB), Vol. 76, Pt 2, 267-72 (Aug., 1960).

From theoretical calculations carried out for the two trihalides AsF_3 and $AsCl_3$ using the molecular orbital method, estimates of hybridization and ionic character in the bond orbital were obtained using the observed values of the dipole moments. These are compared with corresponding data from quadrupole coupling constants.

872 STUDY OF BOND POLAR PROPERTIES.

J.Morcillo, J.Fernández Biarge and J.Herranz.

An. Real. Soc. Espan. Fis. Quim. (Spain), Vol. 55(A), No. 9-10, 267-82 (Sept.-Oct., 1959). In Spanish.

The difficulties involved in the interpretation of infrared spectra in terms of bond polar properties are discussed. The intensities of rotation—vibration bands are related directly to parameters which define the polar properties of a molecule, with no resort to dependent values of coefficients in the potential energy functions. The formulae given do not use individual intensities of bands but the sum of all those belonging to vibrations of a given symmetry class. The theory is applied to the ordinary and deuterated methyl halides. It is shown that to first approximation transferability from one molecule to another of bond polar properties is justified.

T.E.Peacock

873 MAGNETIC RESONANCE OF DIFFERENT FERRIC COMPLEXES.

J.F.Gibson, D.J.E.Ingram and D.Schonland.

Disc. Faraday Soc. (GB), No. 26, 72-80 (1958).

"Ions of the transition elements" conference paper (see Abstr. 20727 of 1960). This paper summarizes the results of electron resonance measurements on different derivatives in which a transition metal atom is held at the centre of a square of four nitrogens. All the complexes studied contained a porphyrin or porphyrin-like plane, and most of the measurements were on different ferrihaemoglobin derivatives. The g-value variations with respect to the porphyrin plane are summarized for the different types of bonding with the iron atom, and then some earlier measurements on similar copper and cobalt complexes are quoted for comparison. The first-order molecular-orbital treatment of these square-bond derivatives is then given and it is shown that the order of the predicted energy-level splittings is the same as for those of the octahedral complexes.

874 SATELLITE LINES IN PARAMAGNETIC RESONANCE SPECTRA.

A. van Roggen.

J. chem. Phys. (USA), Vol. 33, No. 5, 1589-90 (Nov., 1960).

The e.s.r. spectrum of p-benzosemiquinone in dilute solution shows a five line hyperfine structure due to interaction of the free electron with four equivalent protons. Each of these lines has two weak satellites, one on either side, which are interpreted as due to molecules in which one of the C^{12} atoms has been replaced by a C^{13}.

J.M.Baker

875 ANALYSIS OF HIGH-RESOLUTION N.M.R. SPECTRA BY ITERATIVE METHODS.

R.A.Hoffman.

J. chem. Phys. (USA), Vol. 33, No. 4, 1256-7 (Oct., 1960).

The close connection between some iterative procedures for analysing n.m.r. spectra advanced by Reilly and Swalen (Abstr. 11539 of 1960), and a perturbation method described by the author [Ark. Kemi (Sweden), Vol. 15, Paper 6, (1959)], is pointed out.

E.F.W.Seymour

876 ON THE ANALYSIS OF HIGH-RESOLUTION N.M.R. SPECTRA BY ITERATIVE METHODS.

C.A.Reilly and J.D.Swalen.

J. chem. Phys. (USA), Vol. 33, No. 4, 1257-8 (Oct., 1960).

A brief reply to the comments of Hoffman (see preceding abstract). E.F.W.Seymour

877 CHEMICAL SHIFTS IN NUCLEAR MAGNETIC RESONANCE IN THE LIGHT OF NEW INVESTIGATIONS OF MAGNETIC PROPERTIES. Ya.G.Dorfman.

Dokl. Akad. Nauk. SSSR, Vol. 134, No. 4, 789-91 (Oct. 1, 1960).
In Russian.

A brief account is given of the further development of a method (Dorfman, Zhurnal Fizicheskoi Khimii, Vol. 33, 1299, 1959) of calculating chemical shifts in n.m.r. from magnetic susceptibility data and the relation discussed between these two magnetic properties of molecules. A table is given which shows good agreement with experiment of chemical shifts calculated by this method.

J.G.Powles

878 PROTON RESONANCE IN DIPHENYL PICRYL HYDRAZYL.

M.E.Anderson, G.E.Pake and T.R.Tuttle, Jr.
J. chem. Phys. (USA), Vol. 33, No. 5, 1581-3 (Nov., 1960).

Different Knight shifts associated with various proton-hyperfine couplings in crystalline α,α-diphenyl-β-picryl hydrazyl (DPPH) have been resolved in the range 4.2 to 1.4°K. The shifts show a 1/T dependence consistent with the assumption that the shifts arise from exchange narrowed hyperfine interactions. A deuterium substitution experiment permitted the identification of one of the lines. A preliminary experiment on a single crystal revealed some anisotropy in the spectrum.

J.M.Baker

879 N.M.R. ANALYSIS OF CF_3CF_2CFICl: EXAMPLE OF AN UNEXPECTED SPIN-COUPLING CONSTANT.

L.M.Crapo and C.H.Sederholm.
J. chem. Phys. (USA), Vol. 33, No. 5, 1583-4 (Nov., 1960).

From an analysis of the fluorine magnetic resonance spectrum observed under high resolution at 56 Mc/s, it is inferred that the coupling constant between the fluorine spins of the CF_3 and CF_2 groups is 0 ± 0.3 c/s. Other cases where this constant is nearly zero are listed.

E.F.W.Seymour

880 PROTON RESONANCE SHIFTS IN PYRENE MONO-NEGATIVE ION AT 4.2°K.

M.E.Anderson, P.J.Zandstra and T.R.Tuttle, Jr.
J. chem. Phys. (USA), Vol. 33, No. 5, 1591-2 (Nov., 1960).

Values of the proton—electron hyperfine coupling constants, deduced from the proton magnetic resonance spectrum at 4.2°K and from the electron spin resonance of the ion in dilute solution, are compared and the origin of the considerable differences considered.

E.F.W.Seymour

881 N.M.R. SECOND MOMENT OF A RADICAL ROTATING IN A PERIODIC POTENTIAL. A.Miyake and R.Chûjô.

J. Phys. Soc. Japan, Vol. 14, No. 7, 978-9 (July, 1959).

Expressions are derived for the second moment of a resonance due to nuclei in a radical rotating in an n-fold periodic potential, applicable to high temperatures where the radical jumps from one potential trough to another, and to lower temperatures where the radical is confined to a single trough.

E.F.W.Seymour

882 THE SPIN--SPIN RELAXATION TIME OF DIPHENYL PICRYL HYDRAZYL IN WEAK FIELDS.

R.Roest and N.J.Poulis.
Physica (Netherlands), Vol. 25, No. 12, 1253-4 (Dec., 1959).

Measured as a function of the magnetic field strength H_0 from 2.5 to 20 Oe, at different temperatures.

883 INTERACTION BETWEEN SINGLET GROUND AND EXCITED MOLECULES. G.J.Hoijtink.

Z. Elektrochem. (Germany), Vol. 64, No. 1, 156-7 (1960).

The mechanism of concentration quenching of luminescence is considered, interaction being between like molecules with a centre of symmetry.

G.F.J Garlick

COLLISIONAL DEACTIVATION OF HO_2^*. See Abstr. 21272 of 1960.

884 THE ROLE OF MULTIPOLE INTERACTION EFFECTS IN VAN DER WAALS ATTRACTION. F.Berencz.

Acta. Phys. Hungar., Vol. 12, No. 1, 1-12 (1960). In German.

The expression for the interaction between two molecules is generalized to include dipole, quadrupole, and octupole interactions. It is shown that the dipole—octupole interaction energy is of the sam order of magnitude as the quadrupole—quadrupole interaction and hence if one uses an approximation procedure both effects must be considered or omitted. As an example the perturbation energy for the interaction between two hydrogen atoms is calculated. It is found that the dipole—quadrupole, the quadrupole—quadrupole and th dipole—octupole interaction energies amount, respectively, to 53%, 13%, and 23% of the dipole—dipole energy.

W.J.Orville-Thomas

885 ONSET OF CORRELATION IN INITIALLY UNCORRELATED SYSTEM. I.R.Senitzky.

Phys. Rev. (USA), Vol. 121, No. 1, 171-81 (Jan. 1, 1961).

The system under consideration is a number of molecules contained in a resonant cavity and isolated from external influences. The molecules are assumed to have two energy levels, and the molecular frequencies have a Gaussian distribution centred at the cavity frequency; the initial states of the molecules are uncorrelated. The onset of correlation in the molecular behaviour is studied by examining the field in the cavity and the power emitted by the molecules for effects depending on the square of the number of molecules, in a perturbation theory approach. It is shown that correlation effects manifest themselves in the fourth-order interaction. Both the correlation energy in the field and the correlation power emitted by the molecules approach steady-state values after transient periods determined by the relaxation time of the cavity and the frequency spread of the molecules. A physical picture of the correlation effects, as being due to induced emission produced by the lowest order spontaneous and thermal emission, is investigated and found to be approximately correct. The ratio of correlation energy to lowest order spontaneous emission energy is derived. An analysis is made of the dependence of the results on the initial states of the molecules, and interpreted in terms of the physical picture. The effect of the presence of a number of cavity modes, rather than a single mode, within the frequency spread of the molecules is investigated under simplifying assumption, and is shown to multiply the correlation effects by the square of the numb of modes.

BIREFRINGENCE OF POLYPROPYLENE: C—C AND C—H BO POLARIZABILITIES. See Abstr. 20971 of 1960.

886 POLARIZATION AND FOCUSING OF MOLECULAR BEAMS BY DIPOLE FIELDS. H.Friedmann.

Z. Phys. (Germany), Vol. 161, No. 1, 74-88 (1960). In German.

General and specific aspects of focusing fields are considered; treatment is in terms of magnetic fields acting on magnetic dipoles but is readily extended to the case of molecular dipoles in electrostatic fields. Dipolar fields with two symmetry-planes [Friedmann Physikalische Verhandlungen, Vol. 9, 236 (1958)] allow increased intensity through use of a slit as source, aligned perpendicular to the focusing plane. Detailed discussion is given of the "two wire" field, that due to two thin, straight, parallel conductors, carrying equal and opposite currents, or the corresponding orthogonal field between hemicylindrical pole pieces. Advantages over six-pole fields include greater simplicity, allowing focusing of a larger soli angle, increased sensitivity, and the fact that, in the focusing space the field is practically homogeneous and always finite. The last fact helps to produce clean polarized beams by preventing non-adiabatic depolarization processes. The application of such a field to the polarization of an atomic beam is considered, for cases wher the atomic dipole is fixed, and also where it is field-dependent. More complex fields with two symmetry-planes are also considere in which extra field-elements are added in such ways as to reduce deviations from harmonicity in the force-displacement relationship for the particle. The application of dipole fields in polarization an analysis in molecular beam resonance experiments is discussed. Practical details are given of polarization tests with a beam of potassium atoms in a dipole field. An intensity of polarized atoms of 10^{14} particles per second, corresponding to 16 μA, is attained.

J.Sherida

SOLID-STATE PHYSICS

887 THE PARTICLE CONCEPT AND SOLID STATE PHYSICS.
G.H.Wannier.
xperientia (Switzerland), Vol. 16, No. 6, 229-37 (1960).

Review for non-specialists, tracing the origins and development f particle and quasi-particle (phonon, spin-wave quantum, etc.) oncepts.

888 DIAMOND. II.
S.Tolansky.
ontemporary Physics (GB), Vol. 1, No. 4, 276-86 (April, 1960).

For Pt I see Abstr. 3391 of 1960. A brief review is given of ome recent solid-state physics studies made on diamond. These nclude both the ultraviolet and the infrared absorption spectra of iamond; the classification of duanibds; a survey of the semi-conducting properties exhibited by some diamonds; diamond luminescence; nd some of the effects produced when diamonds are subjected to rradiation by high energy particles and by neutrons. The recently eveloped diamond radiation counter and the advantages of such a ounting system are discussed.

889 ON THE DETERMINATION OF IONIC RADII.
K.Sasvári.
cta phys. Hungar., Vol. 11, No. 4, 333-51 (1960).

With the aid of ionic close packing, ideal crystal lattices can be iven to many distorted ionic crystal lattices. Because of distortion he actual lattices are usually dilated compared to the ideal ones, so hat the difference of the volumes associated with one anion of the ctual and ideal lattice, respectively, always satisfies the relation .V(X) ≥ 0. For every group of ionic compounds with the same nion, but different cations of the same valency and coordination umber and only slightly differing ionic radii, the volume difference .V(X) will be the same. With this supposition the ionic radii of the ations present in rutile, its sister lattices, and CaF_2 could be etermined. For the cases considered the ionic radii of Ahrens are ost reliable. In the other cases, Goldschmidt's radii or intermediate values of the two have to be regarded as the real ones. ome deviation can be found for the ionic radii in the case of the ompounds AB_2X_6 in which the divalent cations are Fe, Co, Ni or Mn. he ionic radii have rather a fictitious meaning and their values ary depending on the coordination number as well as on the influence f neighbouring cations, polarizability of the anions and on the relative umber of cations and anions. The ionic radii redetermined in this aper are summarized in tables, where also a comparison with the ate of Goldschmidt and Ahrens is given.

890 TIGHT BINDING METHOD FOR WHITE TIN.
M.Miąsek.
ull. Acad. Polon. Sci. Ser. Sci. math. astron. phys. (Poland), Vol. 8, o. 2, 89-93 (1960).

The energy integrals are worked out in the nearest neighbours pproximation. They contain eleven parameters. L.Pincherle

891 ON THE NATURE OF THE INTERATOMIC INTERACTION IN HYDRIDES OF CERTAIN TRANSITION METALS.
.A.Nemnonov and L.D.Finkel'shtein.
iz. Metallov i Metallovedenie (USSR), Vol. 9, No. 4, 530-4 (April, 960). In Russian.

A study of the K-absorption edges of pure V and VH, containing 5 at.% H, revealed that the first and second absorption lines in the ong wavelength range were considerably weaker in the latter case, s a result of which the centre point of the initial absorption range as shifted by 0.8 eV towards the shorter wavelengths. On the basis f these findings, non-localized ionic-covalent bond was postulated or Ti and V hydrides. According to the proposed theory, the lectron donated by the metal to the H atom cannot, owing to insufficiently large difference in the electro-negative character of he atoms, be closely attached to the H atom. As a result it forms, ogether with the H electron, a non-localized resonance covalent ond with the nearest four metal atoms, each electron pair which orms such a bond being at any given time displaced towards the ore electro-negative (H) atom. M.H.Sloboda

892 A NEW FORM OF THE POLAR MODEL OF A CRYSTAL.
A.E.Glauberman.
Izv. Akad. Nauk SSSR, Ser. fiz., Vol. 24, No. 1, 101-3 (1960).
In Russian.

"1958 Moscow Dielectrics Conference" (see Abstr. 16003 of 1960). The author suggests a new method of transformation to the excitation Hamiltonian in the polar model which takes into account the nature of the background and is a canonical transformation. An example is given of its application to an atomic semiconductor with one s-type valence electron in crossed electric and magnetic fields. M.G.Priestley

893 IONIC—COVALENT BONDING IN CRYSTALS.
C.H.L.Goodman.
Nature (GB), Vol. 187, 590-1 (Aug. 13, 1960).

The concept of bond electronegativity difference (Δx) suggests that when $\Delta x = 0$ bonding electrons must be equally shared between bonded atoms. In simple ionic-covalent solids this occurs not at formal covalency ($Zn^{2-}S^{2+}$ for zinc sulphide) but at a point between it and the formal ionic extreme ($Zn^{2+}S^{2-}$), in fact at zero charge separation or "neutral bonding" (Zn^0S^0). Each atom then has associated with it the complement of valence electrons given by its group in the Periodic Table. Since usually $\Delta x > 0$, bonds are normally more ionic than the neutral form, thus II—VI compounds are formally more than 50% ionic, III—V compounds more than 25%. C.H.L.Goodman

894 EFFECTS OF ATOMIC POLARIZATION IN IONIC CRYSTALS. F.W.de Wette.
Physica (Netherlands), Vol. 25, No. 12, 1225-40 (Dec., 1959).

The effect of higher-order atomic polarizations on the cohesive energy of ionic crystals is treated on the basis of a model according to which the crystal consists of polarizable non-overlapping electrostatic charge distributions. By means of methods developed previously, the multipoles induced in the atoms by the crystalline field are calculated in a self-consistent way. A general formula for the effect of these polarizations on the cohesive energy of ionic crystals is derived and numerically evaluated for the crystals of KCl, KI, CsCl and CsI.

895 QUANTUM-MECHANICAL CALCULATION OF THE COHESIVE ENERGY OF CUPROUS SULFIDE β-Cu_2S CRYSTAL. S.Kobayasi.
Mem. Fac. Engng Hiroshima Univ. (Japan), Vol. 1, No. 2, 113-23 (Dec., 1958).

The lattice energy and the lattice constant of the cuprous sulphide Cu_2S in the β-phase (110-470° C) were calculated by Landshoff's method, on the basis of the following assumptions: (1) the complete-ionic model of Cu^+ and S^{2-} ions and (2) the close-packed arrangement of S^{2-} ions. The computed lattice energy was 480 kcal/mole and the corresponding lattice constant was 5.14 A, while the experimental values are 690 kcal/mole and 3.89 A, respectively. The main origin of the discrepancies may be supposed to be in the inadequacy of the above two (especially the second) assumptions. Other reasonable arrangements of S^{2-} ions as a starting crystal structure are being considered.

LATTICE MECHANICS

896 THE ROLE OF INITIAL STRESSES IN LATTICE DYNAMICS. E.S.Rajagopal.
Ann. Phys. (Germany), Vol. 6, No. 3-4, 177-81 (1960).

It is proved that if one describes the infinitesimal elastic behaviour from the state S, the symmetry of the behaviour follows that of the state S but is independent of the magnitude of the initial stresses frozen in S. The bearing of the result on the current formulations of lattice elasticity is indicated.

897 THE ROTATIONAL INVARIANCE CONDITION IN LATTICE DYNAMICS. E.S.Rajagopal.

Ann. Phys. (Germany), Vol. 6, No. 3-4, 182-91 (1960).

The validity is discussed of the rotational invariance condition used in lattice dynamics. It is pointed out that rotations of non-central fields cannot be represented by displacements alone. Formulating the equations of lattice dynamics referred to Lagrangian coordinates imbedded in the crystal, it is shown that the usual formulae do not strictly represent the physical requirement of rotational invariance. The result has considerable effect on several applications of lattice theory.

898 THE DIPOLE APPROXIMATION IN THE MICROSCOPIC THEORY OF CRYSTALS. I. LATTICE VIBRATIONS WITH ALLOWANCE FOR ELECTRON DISPERSION.

V.S.Mashkevich.

Fiz. tverdogo Tela (USSR), Vol. 2, No. 10, 2629-36 (Oct., 1960). In Russian.

Derives equations of harmonic lattice vibrations in the dipole approximation with allowance for electron dispersion at frequencies far from those corresponding to electron transitions. [English translation in: Soviet Physics—Solid State (USA)]. A.Tybulewicz

899 OPTICAL, ELASTIC AND PIEZOELECTRIC PROPERTIES OF IONIC AND COVALENT CRYSTALS WITH THE ZnS TYPE LATTICE. K.B.Tolpygo.

Fiz. tverdogo Tela (USSR), Vol. 2, No. 10, 2655-64 (Oct., 1960). In Russian.

The properties are evaluated on the basis of the general theory developed in earlier papers (Abstr. 5461-2 of 1958). The vibration equations of the crystal, and the limiting optical and acoustic frequencies are established. Comparison of the equations of acoustic vibrations with the macroscopic equations elasticity and piezoelectricity allows the elastic and piezoelectric constants to be calculated. The theory is applied to copper halides, zinc blende, diamond, Si, Ge, GaSb, InSb, and SiC. [English translation in: Soviet Physic-Solid State (USA)]. R.F.S.Hearmon

900 THE EXISTENCE OF INTERFACIAL COUPLES IN INFINITESIMAL ELASTICITY. E.S.Rajagopal.

Ann. Phys (Germany), Vol. 6, No. 3-4, 192-201 (1960).

The existence of interfacial couples in general crystalline media is established and an extension of the Cauchy stress principle is formulated. A strict method of treating the homogeneous deformation of an infinite lattice is also presented. The relevance of interfacial couples in the theory of elasticity is discussed together with a critical survey of the recent work in this field.

901 ABSORPTION OF ULTRASONIC WAVES IN ALKALI-HALIDE CRYSTALS. L.G.Merkulov.

Akust. Zh. (USSR), Vol. 5, No. 4, 432-9 (1959). In Russian. English translation in: Soviet Physics — Acoustics (USA), Vol. 5, No. 4, 444-50 (April-June, 1960).

LiF, NaCl, KCl, and KBr crystals were investigated. The absorption of longitudinal and transverse waves was measured for different crystallographic directions in a frequency range 5-200 Mc/s and a temperature interval from −120° to +300°. The velocity was also measured and the elastic constants of the crystals were calculated. The results obtained were judged on the basis of dislocation theory. The role of thermoelastic losses and the processes connected with a change in the phonon distribution is evaluated.

902 ULTRASONIC ATTENUATION IN S.A.E. 3140 AND 4150 STEEL. E.P.Papadakis.

J. Acoust. Soc. Amer., Vol. 32, No. 12, 1628-39 (Dec., 1960).

The attenuation of longitudinal ultrasonic waves from 5 to 95 Mc/s is studied by the pulse technique in blocks of SAE 3140 and 4150 steel to determine the loss mechanism and to find possible methods for precision testing the microstructure of materials. It is found that scattering by the grains in the polycrystalline steel is responsible for the attenuation in tempered structure. The critical quantities are the grain diameter and the average squared fractional variation in the elastic modulus of a single grain. It is found that the attenuation is given within experimental limits in the case of steel with martensitic structure by the expression for Rayleigh scattering derived by Mason and McSkimin for the case of the wave length much smaller than the grain diameter and by the expression for stochastic phase scattering derived by Huntington for the case o the wavelength to grain diameter ratios between $\frac{1}{3}$ and 3. The value of the average squared fractional variation in the elastic modulus (entering both expressions to the first power) was the one given by Mason and McSkimin for iron crystals. Bainite appears to have a higher value of this quantity. An alternative theory by Lifshits and Parkhomovskii may explain bainite. Tempering removed an elasticity from quenched structures. Suggestions for the exact solution for the attenuation at all frequencies are made, and method of materials testing to investigate grain size and grain quality are outlined. Diffraction corrections and other items relevant to ultrasonic attenuation measurements are mentioned.

903 ORIGIN OF HYPERSONIC ATTENUATION IN GERMANIUM AT LOW TEMPERATURES.

G.S.Verma and S.K.Joshi.

Phys. Rev. (USA), Vol. 121, No. 2, 396 (Jan. 15, 1961).

Hypersonic attenuation in germanium at different temperatures is calculated and compared with the recent low-temperature measurements by Truell and his associates (Abstr. 11573 of 1960). The excellent agreement between the theory and experiment for the temperature dependence shows that Umklapp processes are responsible for the attenuation at low temperatures.

904 THEORY OF ULTRASONIC ATTENUATION IN METALS AND MAGNETO-ACOUSTIC OSCILLATIONS.

A.B.Pippard.

Proc. Roy. Soc. A (GB), Vol. 257, 165-93 (Sept. 6, 1960).

The attenuation of an ultrasonic wave by direct interaction with the conduction electrons in a metal is analysed, without making any special assumptions about the shape of the Fermi surface. The problem is reduced to a calculation of the currents set up in a stationary lattice by forces on the electrons, some real (due to electric fields) and some fictitious to describe the disturbances due to the passage of the wave. The fictitious forces have their origin in the relative motion of different parts of the metal and in the change in shape of the equilibrium form of the Fermi surface as a result of lattice deformation. It is assumed, as is valid for ultrasonic frequencies below about 10^9 c/s, that the electric fields serve to annu any electronic current relative to the lattice. The expressions obtained are qualitatively similar to the earlier results for a free-electron model, in particular the attenuation tends to a constant limit as the electronic free path becomes infinite. Only for a pure longitudinal wave is the limit simple in form and there it is determined by the Gaussian curvature and the mean square value of the deformation parameter round that zone of the Fermi surface on which the electrons move parallel to the wave front. The analysis is extended to cover the situation which arises in a transverse magnetic field, in the limit when the free path is long compared wit the electronic orbit perimeters. The results are very complicated but qualitatively similar to the free-electron results in the types of oscillatory behaviour predicted and in the limiting values of the attenuation as the magnetic field increases without limit; if there a open orbits present, however, the limiting behaviour is changed, the attenuation of longitudinal waves for instance tending to infinity as H^2. Although the oscillatory behaviour may usually be governed by the extreme extensions of the Fermi surface in a direction normal to H and to the direction of propagation, it is suggested that this is not likely to hold if the deformation parameter is very variable over the Fermi surface, as is probable in the noble metals, and that the oscillations may then indicate the positions of parts of high deformability.

905 THE INTERACTION OF LONGITUDINALLY POLARIZED VIBRATIONS IN AN ISOTROPIC DIELECTRIC. S.Simons.

Proc. Cambridge Phil. Soc. (GB), Vol. 57, Pt 1, 86-95 (Jan., 1961).

A theoretical treatment is given of the relaxation time for the absorption of longitudinally polarized vibrations in an isotropic medium. Employing standard phonon interaction theory, the relaxation time is obtained in terms of certain integrals, depending parametrically on the ratio of transverse to longitudinal sound velocity. These integrals are evaluated numerically over the range which this ratio takes in practice. The results are applied to a consideration of solid argon, sodium chloride and germanium.

906 SOME ASPECTS OF THE INTERACTIONS BETWEEN ELECTROMAGNETIC AND ELASTIC WAVES IN OLIDS.

J.P.Mathieu, H.Poulet and A.Tramer.
. Elektrochem. (Germany), Vol. 64, No. 5, 699-701 (1960).
 French.

The elastic waves which represent the normal modes of vibra- on of a perfect crystal have a frequency depending upon the wave- ngth and the direction of propagation. If these waves produce a ipolar polarization of the crystal, then changes can occur in the equency and attenuation of the absorbed or diffused light waves, epending on the relative orientation of the elastic wave vector and e polarization vector. These changes are illustrated by reference crystal studies involving the Raman effect, X-ray diffusion and e reflection and absorption of infrared radiation.

H.J.H.Starks

907 EXCHANGE AND CORRELATION CORRECTIONS TO THE ELECTRON—PHONON INTERACTION.

D.Hone.
hys. Rev. (USA), Vol. 120, No. 5, 1600-6 (Dec. 1, 1960).

The method of Bardeen and Pines (Abstr. 8948 of 1955) for reating electron—phonon interactions in normal metals is extended include exchange and correlation effects. The interaction matrix lement is found to depend not only on electron momentum transfer ut also on the initial electron wave vector. An average over ini- al wave vector direction is therefore made; the average taken is iscussed as being more reasonable than that of Bailyn in a previous reatment. Shielding is also introduced in a more physical manner han in Bailyn's paper - via the dielectric constant as it arises in e random phase approximation. An alternate method of treating e problem in the long wavelength limit - employing deformation otential techniques - verifies the results of the above method in is limit.

908 PLASMA THEORY OF ELECTRON—PHONON INTERACTION IN METALS.

O.von Roos.
hys. Rev. (USA), Vol. 120, No. 5, 1641-7 (Dec. 1, 1960).

The transport theory of an electron gas (Abstr. 15007 of 1960) s extended to include the interaction with the ions in a metal. The erturbation of the lattice vibrations induced by an anisotropy of e electron distribution is calculated. Subsequently the ionic egrees of freedom are eliminated from the transport equation of e electrons in favour of a long-range electron correlation term. he influence of this term becomes important at long wavelengths n the far infrared) but constitutes a small perturbation for the igenfrequencies of collective motion of the electron gas. Never- eless the dispersion relation for the collective oscillations shows at the contributions due to the phonon interaction are of the same rder of magnitude as the influence of thermal agitation.

hermal Properties

909 DERIVATION OF POTENTIAL ENERGY OF CRYSTALS FROM THERMODYNAMIC DATA.

B.Dayal.
roc. Nat. Inst. Sci. India A, Vol. 25, No. 4, 206-9 (July 26, 1959).

In the present method an average Grüneisen constant is lculated from the experimental data on the thermal expansion, ecific heat and compressibility. This enables one to calculate the ermal pressure as a function of the volume in the usual manner. he pressure for a non-vibrating lattice at T = 0 at a given volume calculated from the condition that the sum of the static and thermal essures is equal to the total pressure under which the volume is perimentally measured. The static pressure being the derivative the potential energy, the latter can be calculated from it. The ethod is capable of being applied to non-cubic crystals. Several rms of potential energy functions have been tested by this method.

910 SPECIFIC HEATS AND ENTHALPIES OF TECHNICAL SOLIDS AT LOW TEMPERATURES. A COMPILATION ROM THE LITERATURE.

R.J.Corruccini and J.J.Gniewek.
at. Bur. Stand. Monogr. (USA), 21, 1-20 (1960).

Tables are given of the specific heat c_p and the enthalpy of 3 metals, 3 alloys, 8 other inorganic substances, and 8 organic ubstances in the temperature range from 1° to 300°K.

911 THE SPECIFIC HEATS OF SOLID ARGON AND AN EQUIMOLAR ARGON--KRYPTON MIXTURE.

B.F.Figgins.
Proc. Phys. Soc. (GB), Vol. 76, No. 5, 732-6 (Nov., 1960).

The specific heat of argon was measured over the temperature range 16° to 35°K. The results were used to calculate a value for the Debye θ, which was in excellent agreement with lattice dynamics. The specific heat of an equimolar argon—krypton mixture was measured from 12°K to the melting point. No evidence of any phase separation could be found from the results.

912 THE SPECIFIC HEATS OF TWO POLYMORPHIC FORMS OF MANGANOUS SULPHIDE, AND THE INFERRED POSSIBILITY OF ANTIFERROMAGNETIC ORDERING IN STACKING FAULTS.

W.S.Carter.
Proc. Phys. Soc. (GB), Vol. 76, Pt 6, 969-78 (Dec. 1, 1960).

Reports measurement of the specific heats in the range 76°K to 250°K of two samples of manganous sulphide. The samples used crystallized in the zincblende and wurtzite structures were the same as in the magnetic susceptibility measurements reported previously. The large anomaly in the specific heat of sample 1 confirmed the onset of antiferromagnetic ordering in the zincblende structure at 100°K. The absence of a similar large anomaly in specimen 2 above 76°K showed that the wurtzite structure remained unordered at this temperature, but there was a small anomaly at 110°K. A study of the X-ray powder photographs, and the calculation of Madelung's constant for several possible types of stacking faults, showed that this anomaly in the specific heat was consistent with magnetic ordering within stacking faults. The possibility that the presence of ordered stacking faults may depress and smooth out the Néel temperature of the rest of the sample was also considered, and was suggested as a possible explanation for the absence of a Néel temperature above 76°K in specimen 2 whilst a specimen composed entirely of a wurtzite structure was shown to order above this temperature by Corliss et al. (1956).

913 CORRELATION EFFECTS ON THE ELECTRONIC SPECIFIC HEAT OF SODIUM.

E.A.Stern.
Phys. Rev. (USA), Vol. 121, No. 2, 397-402 (Jan. 15, 1961).

The effect of the martensitic transformation in sodium on measured values of its specific heat is analysed. It is shown that the only important effect at low temperatures is to produce a mixture of the two phases. The measured specific heat is very closely given by the sum of the specific heats of each phase measured separately. An analysis of the various experimental measurements gives the result that the effective mass of conduction electrons in the b.c.c. high-temperature phase is greater than 1.5 times the free electron mass, while in the h.c.p. low-temperature phase the corresponding value is less than 1.21. Using further experimental data it is estimated that the effective masses in the b.c.c. high-temperature phase and the h.c.p. low-temperature phase are 1.7 and 1.1 times the free electron value, respectively. These effective mass values imply that there is substantial contact of the Fermi surface in the h.c.p. structure with the "A" faces of the Brillouin zone. The large effective mass in the b.c.c. phase indicates a large enhancement of the specific heat of the conduction electrons in sodium by correlation and electron—phonon interaction effects. The correlation effects alone appear to increase the specific heat of a free electron gas at a density corresponding to $r_s = 3.96$ (in units of the Bohr radius) by about 40%.

914 DEBYE TEMPERATURE OF ORTHORHOMBIC CRYSTALS AT 0°K.

S.K.Joshi.
Phys. Rev. (USA), Vol. 121, No. 1, 40-1 (Jan. 1, 1961).

Explicit formulae are obtained for the Debye characteristic temperature of orthorhombic crystals by an extension of Houston's method of expanding the integrand involved in terms of appropriate harmonic polynomials. Θ (elastic) values were computed for twelve crystals and the results are discussed.

915 DEBYE CHARACTERISTIC TEMPERATURE OF SOLIDS.

S.K.Joshi and S.S.Mitra.
Proc. Phys. Soc. (GB), Vol. 76, Pt 2, 295-8 (Aug., 1960).

Debye characteristic temperatures for a number of solids belonging to cubic, hexagonal, tetragonal and trigonal crystal systems were calculated from their elastic constants using series expansion and numerical methods.

DEBYE TEMPERATURE OF TIN AND CsBr FROM ADIABATIC ELASTIC CONSTANTS. See Abstr. 1293-4

916 THERMAL EXPANSION OF α-Sn, InSb AND CdTe.

S.I.Novikova.

Fiz. tverdogo Tela (USSR), Vol. 2, No. 9, 2341-4 (Sept., 1960). In Russian.

Linear expansion coefficient (k) of grey tin (α-Sn), InSb and CdTe became negative below 45.0, 57.5 and 71.5°K, respectively. In the case of CdTe, a negative maximum ($k = -0.334 \times 10^{-5}$ deg^{-1}) was observed at 37.5°K. [English translation in: Soviet Physics—Solid State (USA)]. A.Tybulewicz

917 A THEORETICAL STUDY OF THE COMPRESSIBILITY, THERMAL EXPANSION AND EQUATION OF STATE OF ROCKSALT UP TO ITS MELTING POINT.

B.Dayal and S.Tolpadi.

Proc. Nat. Inst. Sci. India A, Vol. 25, No. 4, 214-19 (July 26, 1959).

Experimental data on the compressibility and the thermal expansion of rocksalt are available up to its melting point. It is, therefore, of interest to derive these quantities theoretically. The frequency expressions of several typical frequencies were differentiated to obtain the corresponding Grüneisen constants. From these an average constant has been obtained for evaluating the thermal pressure. The frequencies taken are those which appear in the Raman model. The static pressure has been obtained from the potential energy expression given by Huggins and Mayer (1933). It is found that the calculated isotherm at 348°K agrees very well with the experimental one. There is satisfactory agreement between the calculated and the experimental values of the thermal expansion and the compressibility up to the melting point. The isotherm corresponding to a temperature of about 1350°K has a minimum on the zero pressure axis and this temperature is about 25% higher than the observed melting point.

918 THERMAL EXPANSION OF SIMPLE IONIC CRYSTALS.

S.Kumar.

Proc. Nat. Inst. Sci. India A, Vol. 25, No. 6, 364-72 (Nov., 1959).

The amplitude of thermal vibration in an ionic lattice increases with rise of temperature resulting in expansion of the lattice. Due to this increase in interionic distance the frequencies with which the ions vibrate also change. From these considerations it is shown that the coefficient of linear thermal expansion for a simple ionic crystal is

$$\alpha = \frac{C_V}{nE_0}\frac{n+4}{2}, \quad \ldots \ldots \ldots \ldots \ldots \ldots \ldots \text{(a)}$$

where C_V is the specific heat at constant volume, E_0, the crystal energy and n, the Born constant. To account for the increase in thermal expansion due to ionic polarization, certain empirical changes are made and the equation (a) changes to

$$\alpha = \frac{C_p}{nE_0} \cdot \frac{(n+4)\sqrt{Z}}{2} \quad \ldots \ldots \ldots \ldots \ldots \ldots \text{(b)}$$

where C_p is the specific heat at constant pressure and $Z = \frac{Z_c N_c + Z_a N_a}{2} N_c$, Z_c and N_a, Z_a being the number and charge of the number and charge of the cation and anion respectively. For LiI, TlCl, CsCl, PbS and PbO_2 crystals in which polarization effect is more pronounced, equation (b) is used for calculating α while for the other alkali halides, silver halides, alkaline earth oxides, ZnS, CaF_2, Al_2O_3, TiO_2 and SiO_2, α is calculated by assigning an empirical factor 5 to the term $(n + 4)/2$ in equation (b). Most of the calculated values are within 10% of the experimental data, excepting for SiO_2 (Quartz), TiO and ZnS. Unusually large thermal expansion of SiO_2 compared to the calculated value is ascribed to rotational movements of the (SiO_4) groups, which are not considered in deriving the equation. With rise of temperature increase in α (experimental) for CaF_2 and KI is more than α (calculated).

919 MELTING TEMPERATURES OF KRYPTON, XENON, AND METHANE AT PRESSURES UP TO 3000 ATM.

J.C.Stryland, J.E.Crawford and M.A.Mastoor.

Canad. J. Phys., Vol. 38, No. 11, 1546-7 (Nov., 1960).

The melting points T, the triple points T_0, and the best values for a and c in Simon's melting point formula $p/a = (T/T_0)^c - 1$ are listed. The apparatus consisted of a narrow tube which contained, in addition to the substance under study, a plunger which could be lifted and dropped electromagnetically from outside the crystal. The freezing of the substance was detected by the arrest of the plunger. S.Weintroub

920 THERMAL TRANSPORT IN DILUTE ALLOYS.

G.K.White.

Austral. J. Phys., Vol. 13, No. 2a, 255-9 (July, 1960).

Solid State Physics Conference (see Abstr. 17864 of 1960). Experimental values of the thermal resistivity for a number of elements, including copper, silver, gold, argon, germanium, silicon, antimony, and bismuth, were compared with theoretical values deduced from the anharmonic coupling between lattice vibrations. For copper-, silver-, and gold-rich alloys, experimental and theoretical data for scattering of lattice waves by point defects were cor pared.

921 THE LATTICE THERMAL CONDUCTIVITY OF ALLOYS

W.R.G.Kemp and P.G.Klemens.

Austral. J. Phys., Vol. 13, No. 2a, 247-54 (July, 1960).

Solid State Physics Conference (see Abstr. 17864 of 1960). The lattice thermal conductivity of alloys at liquid-helium temperatures yields information about the nature of the electron—phonon interaction, and about the density of dislocations. It appears that, in copper, silver, and gold the electrons interact with transverse as well as with longitudinal lattice waves. The lattice conductivity also varies with alloy composition; it is not clear whether this variation should be ascribed to changes in the electron density or to the presence of dislocations, locked into stable configurations by the solute atom. If the latter view is adopted, the density of dislocations in annealed alloys is typically of the order of 10^{10} to 10^{11} lines/cm^2. Changes of the lattice thermal conductivity of deformed alloys were compared with stored energy release; this suggests that the theory underestimates the scattering of phonons by dislocations by a factor of 3 to 6.

922 THE THEORY OF THERMAL CONDUCTIVITY OF FERROMAGNETIC DIELECTRICS AT LOW TEMPERATURES.

A.I.Akhiezer and V.G.Bar'yakhtar.

Fiz. tverdogo Tela (USSR), Vol. 2, No. 10, 2446-9 (Oct., 1960). In Russian.

In the previous calculation of the contribution of spin waves (Abstr. 7856 of 1958), only one type of interaction between spin waves was considered — two coalescing to form one, or one spin wave splitting into two. The effect of 'exchange' scattering is now determined and some earlier inaccuracies corrected. Formulae for the thermal conductivity are given for $\Theta_D \ll \Theta_C$ (the Debye and Curie temperatures) and $\Theta_D \gg \Theta_C$. [English translation in: Sovie Physics—Solid State (USA)]. R.Berma

923 RESISTANCE ANISOTROPY AT LOW TEMPERATURES

S.Simons.

Proc. Phys. Soc. (GB), Vol. 76, Pt 4, 458-64 (Oct. 1, 1960).

Gives a theoretical treatment, based on the variational principl for the thermal conductivity tensor of dielectrics at low temperatur where N-processes predominate. The general expression is develo in the case where U-processes are the only ones not conserving wave-number, and the ratio of components of the conductivity tenso at very low temperatures is here shown to depend only on the geometry of the lattice unit cell. The results are applied to different crystal structures, and a satisfactory comparison is made with the somewhat meagre available experimental data on quartz and sapphire.

924 THE THERMAL CONDUCTIVITY OF MOLECULAR CRYSTALS WITH INTERNAL ROTATION.

V.Sergiescu

Stud. Cercetari Fiz. (Roumania), Vol. 9, No. 4, 451-7 (1958). In Roumanian.

The influence of the internal rotation on the thermal conductivi of a molecular crystal can be described by a linear relation betwe the coefficients of the potential energy (including the third order terms) and the Fowler rotation parameter. From a semi-quantitat discussion it follows that changes in the thermal conductivity—temperature curve may appear in the Peierls region. The nature of such changes is analysed.

925 THERMAL CONDUCTIVITY IN THE TUNGSTEN CARBIDE—COBALT SYSTEM.

O.Rüdiger and A.Winkelmann.

Tech. Mitt. Krupp (Germany), Vol. 18, No. 1, 19-24 (Aug., 1960). In German.

A correlation is established between the Lorenz number, the thermal and electrical conductivities and concentration. The thermal and electrical conductivities are at a minimum when the cobalt content is 94% by volume, which is the solubility limit of cobalt in tungsten carbide. The Lorenz number decreases monotonously with an increase in cobalt content. Relationships are stablished between the Lorenz number, the electrical and thermal onductivities, and temperature in the range from 25° to 45°C, and etween thermal conductivity and density.

ELECTRON STATES

926 THE SPLITTING OF THE ENERGY LEVELS IN A CRYSTAL AND THE CALCULATION OF THE BINDING ENERGY. R.Sexl.

Acta phys. Austriaca, Vol. 13, No. 4, 476-82 (1960). In German.

A one-dimensional Kronig–Penney model with N δ-function potential wells is considered. The eigenvalues, and the cohesion nergy per atom, are worked out explicitly as functions of N for he case when $\exp(-ka) \ll 1$, where k is the wave vector and a the attice parameter. L.Pincherle

927 BAND STRUCTURE OF MONOVALENT METALS AND THEIR ALLOYS. P.G.Klemens.

Austral. J. Phys., Vol. 13, No. 2a, 238-46 (July, 1960).

Solid State Physics Conference (see Abstr. 17864 of 1960). The consequences of the Bloch theory of the conduction properties of metals can be evaluated only for a band of spherical Fermi surace, isotropic in all respects. Quantitative comparison with observations is thus possible only for the monovalent metals. It appears hat even the monovalent metals do not satisfy this requirement, but that their Fermi surface departs significantly from sphericity. The information derived from the various conduction properties and the electronic specific heat is discussed, paying attention to umklapp processes and phonon-drag effects. The thermoelectric power is difficult to interpret. Systematic measurements of the changes of various physical properties on alloying may provide useful information.

928 BAND STRUCTURE OF RUTILE DEDUCED FROM ITS OPTICAL AND ELECTRICAL PROPERTIES.

P.Moch, M.Balkanski and P.Aigrain.

C.R. Acad. Sci. (France), Vol. 251, No. 14, 1373-5 (Oct. 3, 1960). In French.

The optical absorption of single crystals and of thin films was measured in the temperature range 295 to 77°K. The results, combined with those of electrical measurements reported previously by Cronemeyer (1951), are analysed to give a band model for the centre of the Brillouin zone. C.A.Hogarth

929 ON THE BAND STRUCTURE OF A CRYSTAL OF THE DIAMOND TYPE. A.A.Nran'yan.

Fiz. tverdogo Tela (USSR), Vol. 2, No. 7, 1650-5 (July, 1960). n Russian.

The method of equivalent orbits was applied to crystals of the diamond type using a non-orthogonal system of equivalent orbit unctions. The secular determinant was solved at several points of high symmetry; this contained overlap integrals of the equivalent rbit functions for various valence bonds. The interaction and verlap integrals for anti-bonding functions were calculated, and his was followed by a calculation of the energies of conduction lectrons at certain points of high symmetry in the Brillouin zone. The overlap integrals for the bonding functions were used to stimate the width of the valence band. [English translation in: oviet Physics–Solid State (USA)]. M.G.Priestley

930 SYMMETRY OF ENERGY BANDS IN CRYSTALS OF THE SnSe AND Sb_2S_3 TYPE. F.M.Gashimzade.

Fiz. tverdogo Tela (USSR), Vol. 2, No. 9, 2070-6 (Sept., 1960). n Russian.

Group-theoretical methods were used to deal with electron nergy spectra in semiconductors crystallizing out with lattices of he D_{2h}^{16} space group (orthorhombic syngony). [English translation in: Soviet Physics–Solid State (USA)]. A.Tybulewicz

931 STRUCTURE OF HOLE BANDS IN ALKALI CHLORIDES. T.I.Kucher and K B.Tolpygo.

Fiz. tverdogo Tela (USSR), Vol. 2, No. 9, 2301-9 (Sept., 1960). In Russian.

The dependence is derived of crystal energies of alkali chlorides ontaining holes on the wave-vector k of the holes. A strong-coupling pproximation is used for electrons, together with experimental values f the energy of electron affinity of chlorine. An allowance is made or inertialess polarization of the crystals by the hole fields. In the owest energy band 12 symmetrically distributed minima are found in the directions [110]. Constant energy surfaces are triaxial ellipsoids with strongly differing effective masses. The results are compared with the experimental data reported by Howland (Abstr. 2645 of 1958). [English translation in: Soviet Physics–Solid State (USA)]. A.Tybulewicz

932 DEGENERACY OF ENERGY LEVELS IN CRYSTALS. O.V.Kovalev.

Fiz. tverdogo Tela (USSR), Vol. 2, No. 10, 2557-66 (Oct., 1960). In Russian.

Group-theory methods are used to discuss electron energy-level degeneracy due to space symmetry of a crystal. Possible degeneracy multiplicities are found for all values of the quasi-vector k for each of the 230 space groups. [English translation in: Soviet Physics–Solid State (USA)]. A.Tybulewicz

933 ENERGY BANDS IN THE BISMUTH STRUCTURE. I. A NONELLIPSOIDAL MODEL FOR ELECTRONS IN Bi. M.H.Cohen.

Phys. Rev. (USA), Vol. 121, No. 2, 387-95 (Jan. 15, 1961).

The band structure near a minimum at a point of no special symmetry is examined for energies small compared to all band gaps except that to the next lower band. Spin-orbit coupling is included. The theory is specialized to points having the three possible symmetries of electrons in Bi and further simplifications appropriate to Bi made. The resulting nonellipsoidal energy surfaces are studied in some detail. An experiment is suggested which is capable of distinguishing between the three possibilities. The model is not fitted to existing information in this paper.

934 TOROIDAL ENERGY SURFACES IN CRYSTALS WITH WURTZITE SYMMETRY. R.C.Casella.

Phys. Rev. Letters (USA), Vol. 5, No. 8, 371-3 (Oct. 15, 1960).

The shapes of the constant energy surfaces in the vicinity of the valence and conduction band edges, at $k = 0$, are obtained for several crystals with the wurtzite symmetry by means of the $\vec{k}.\vec{p}$ perturbation technique. For symmetry Γ_7 there is the possibility of toroidal energy surfaces as a direct consequence of the spin–orbit interaction. Observable effects of such surfaces are a possible sharpening of the absorption edge and a strong anisotropy of the Hall coefficient. L.Pincherle

935 METHOD FOR DETERMINING GROUND-STATE SPIN CONFIGURATIONS. D.H.Lyons and T.A.Kaplan.

Phys. Rev. (USA), Vol. 120, No. 5, 1580-5 (Dec. 1, 1960).

The method of Luttinger and Tisza (Abstr. 1043 of 1947; 5554 of 1951) for finding the rigorous minimum of a quadratic forms subject to certain strong constraints is generalized. In the extended method, one still minimizes the quadratic form with respect to a single weak constraint, which however now contains adjustable parameters. In determining the ground state for the classical Heisenberg exchange energy, some cases involving crystallographically non-equivalent spins can now be handled. The following applications are made. The ground state for a linear chain with two different types of spins is obtained. It is then proved that in the cubic spinel the Néel configurations is the ground state if it is locally stable — that is, it is never metastable. This result was assumed in a recent perturbation theory of spin configurations. Finally, a similar result concerning the Yafet–Kittel triangular configurations in noncubic spinels is discussed. In the course of the analysis it is shown that the ground state is always a spiral for any lattice in which the spins are equivalent.

936 EXCHANGE INTERACTION BETWEEN CONDUCTION ELECTRONS AND MAGNETIC SHELL ELECTRONS IN RARE-EARTH METALS. S.H.Liu.

Phys. Rev. (USA), Vol. 121, No. 2, 451-5 (Jan. 15, 1961).

The interaction Hamiltonian for the Coulomb exchange effect between the conduction electrons and magnetic shell electrons is derived from first principles. The approximations under which the interaction can be represented by the product of electron and ion spin vectors are exhibited.

937 A STATISTICAL JUSTIFICATION OF THE CYCLIC CONDITION IN THE ZONE THEORY OF CRYSTALS.

V.Sergiescu.

Stud. Cercetari Fiz.(Roumania), Vol. 9, No. 4, 459-63 (1958). In Roumanian.

It is known by the ergodic theorem that the statistical properties (at equilibrium) of a constant energy system do not depend on its initial state. If, then, the electron in a crystal (or, at least, the whole assembly of electrons) may be supposed practically to conserve its energy, its initial state can be represented by a wave function satisfying the cyclic boundary condition. This property is conserved under the influence of the lattice vibrations. Hence, it is always a permissible procedure to impose the cyclic condition.

938 ELECTRONIC WAVE-FUNCTIONS ROUND A VACANCY IN A METAL. N.H.March and A.M.Murray.

Proc. Roy. Soc. A(GB), Vol. 256, 400-15 (July 5, 1960).

A calculation of the wave-functions round a vacancy in a metal was carried out for a simple model. This corresponds to the case of a finite number of particles in a free-electron metal, with the boundary condition that the wave-functions vanish on the surface of the spherical metal. Calculations are reported for particle numbers of approximately 2×10^2, 2×10^3 and 10^6. The density fluctuations in the unperturbed metal are found to be serious for the first two cases, but by consideration of the difference between the electronic density distributions in the perturbed and the unperturbed cases, extrapolation from the case of a relatively small number of particles to obtain results valid for very large numbers is shown to be feasible difference by consideration only of states of low orbital angular momentum is exploited. Comparison is made between the finite metal results, existing Thomas—Fermi calculations, and a self-consistent von Weizsacker calculation which is also reported here. By examination of the solutions of Poisson's equation, it is shown that the total charge density obtained by summing the squares of the normalized wave-functions for the assumed Thomas—Fermi potential in the 10^6 particle case is such as to make this potential self-consistent to a good approximation. The calculations also reveal long-range oscillations in the total perturbed electron density for finite metals. Although the amplitude of these oscillations decreases with increasing volume, extrapolation to the case of an infinite metal does not seem justified here. However, the calculations should provide an upper bound to the amplitude for the assumed potential and the oscillations are small. Finally, brief reference is made to applications of the present results.

939 AN EXTENDED FORM OF THE WEYL—LAUE THEOREM AND ITS APPLICATION TO SURFACE PROBLEMS. A.Sugiyama.

J. Phys. Soc. Japan, Vol. 14, No. 7, 977-8 (July, 1959).

A formula is proposed for the number of energy levels of electrons in a metal as a function of the wave vector. This gives a correction to the usual form taking into account the effect of the boundary surfaces. It is then used to calculated surface effects upon the interior electron density and the energy of the electron system. K.G.Major

940 SURFACE STATES ASSOCIATED WITH ADSORBED ATOMS. T.B.Grimley.

J. Phys. Chem. Solids (GB), Vol. 14, 227-32 (July, 1960).

When a foreign atom is in interaction with a crystal surface, discrete electron levels may exist. These levels lie outside the normal crystal bands (including any surface bands) and the corresponding wave functions are large on the foreign atom and on the crystal atoms near it in the surface but fall to zero at points in the crystal remote from the foreign atom. Such levels allow for the formation of localized bonds between the foreign atom and the crystal. For semiconducting crystals they can provide surface traps for either electrons or positive holes. When the surface is completely covered by foreign atoms, bands of surface states may exist although no surface states exist when the surface is clean and no discrete levels are formed when only one foreign atom is present.

941 CONTRIBUTION TO THE THEORY OF THE SHOCKLEY SURFACE STATES. I. GENERAL FORMULATION AND THE CASE OF ZERO DEFORMATION OF THE POTENTIAL ON THE GOODWIN—ARTMANN MODEL. J.Koutecky and M.Tomasek.

J. Phys. Chem. Solids (GB), Vol. 14, 241-7 (July, 1960).

Within the framework of the tight-binding method, general equations have been set up for the calculation of orbital energies and wave functions of the electron in a crystal model in which an interaction between atomic s orbitals and p orbitals is assumed. Simple explicit expressions are derived for the case of zero deformation of the potential of the crystal surface. From a discussion of the hybridization of the wave functions of the volume and surface states the connection with the concept of free valence localized in the crystal surface follows.

942 EXCITON MODELS IN THE TIGHT BINDING APPROXIMATION. I.B.Levinson.

Fiz. tverdogo Tela (USSR), Vol. 12, No. 10, 2612-21 (Oct., 1960). In Russian.

The appropriate model depends on the relative magnitude of the energy parameters, the most important being the widths of the hole and electron bands $\Delta\epsilon_V$ and $\Delta\epsilon_C$, and the energy of dissociation of the exciton, E_D. The transfer model applies for $\Delta\epsilon_V$ and $\Delta\epsilon_C \ll E_D$, and the continuum model for $\Delta\epsilon_V$ and $\Delta\epsilon_C \gg E_D$. The applicability of the discussion to particular cases is difficult to as assess because of several generally unknown factors. For Cu_2O for the levels $n \geq 2$, the continuum model should apply, but not for $n = 1$ (borne out by experiment). The applicability of the transfer model can be justified for the lowest levels in alkali halides. It is noted that a hydrogen-like spectrum is not characteristic only of the continuum model. [English translation in: Soviet Physics—Solid State (USA)]. R.Berman

943 THE SHAPE OF EXCITON BANDS IN COPPER OXIDE. L.P.Zverev, M.M.Noskov and M.Ya.Shur.

Fiz. tverdogo Tela (USSR), Vol. 2, No. 10, 2642-6 (Oct., 1960). In Russian.

The line shapes were studied of the second exciton absorption band of the yellow series in thin polycrystalline samples of copper oxide over the temperature range 4.2-90°K. Photoelectric recordin from a diffraction spectrograph with a dispersion of 6 A/mm was used. The results were interpreted on the theory developed by Toyozawa (Abstr. 13508 of 1960) and the line shapes agreed well with this theory for a weak electron—phonon interaction and low effective mass. A lifetime of $\sim 10^{-12}$ sec was deduced from the line width, which was a linear function of temperature above 55°K and constant below this temperature. [English translation in: Soviet Physics—Solid State (USA)]. M.G.Priestley

944 EXCITON PROBLEM AND A NEW APPROACH TO ITS ELECTRONIC STRUCTURE. T.Muto.

Suppl. Progr. theor. Phys. (Japan), No. 12, 3-39 (1959).

After a critical review of the various theories of excitons in crystals the case of "small-size" excitons applicable to alkali halide crystals is considered. A refinement of the original Frenkel and Peierls theory is developed for localized excitons which takes into account the electrostatic interaction of the excited electron with surrounding ions, the latter being included by assuming a perturbed periodic field acting on the electron. This is treated as determining an effective mass parameter. The lowest exciton state is estimated for KCl and shows reasonable agreement with the experimental value. Calculations are then extended to the case of a moving exciton (Frenkel type). The whole approach is later compared with that of Slater and Shockley and it is shown that the energy expressi for the motion of the exciton centre of mass in the present theory is similar to that for tight binding whereas that of the Slater—Shockley theory approximates to the case of a nearly free electron. The marked differences between the sharply defined features of the exciton spectra in Cu_2O (large exciton) and the more diffuse bands for alkali halides (small-size exciton) is thus explained.

G.F.J.Garlic

945 SURVEY OF EXPERIMENTS ON THE EXCITON. M.Ueta.

Suppl. Progr. theor. Phys. (Japan), No. 12, 40-74 (1959).

The general data from which excitons have been inferred is described, and the analysis of absorption spectra for alkali and silver halides is discussed. Evidence for exciton interaction with impurity atoms and vacancies is given such as photoelectric emission from alkali halides and barium oxide, photoconductivity, F-centre formation by X-irradiation, etc. Other cases in which sharp line spectra occur, such as Cu_2O, are reviewed with special reference to line series and to the relations between absorption and photoconduction spectra in HgI_2 and CdS. It is emphasized that information on exciton fluorescence is not at all conclusive, neither is that from exciton diffusion experiments in CdS. G.F.J.Garlic

946 ON THE ELECTRONIC STRUCTURE OF EXCITON. Y.Takeuti.

Suppl. Progr. theor. Phys. (Japan), No. 12, 75-110 (1959).

The theory of exciton levels is developed on the basis of the Slater—Shockley model. Previous calculations (Abstr. 11604 of 1960) neglected the degeneracy of the valence band. The three valence bands are now taken into consideration. The general difference equation for an exciton is derived and solved as in the first paper for zero wave vector (parabolic approximation) and on-zero exciton wave vector, (assuming actual structure of valence nd conduction bands). The results are finally applied to calculations of the lowest members of the exciton bands for KCl.

G.F.J.Garlick

947 ON THE DYNAMICAL BEHAVIOR OF AN EXCITON.
Y.Toyozawa.

uppl. Progr. theor. Phys. (Japan), No. 12, 111-40 (1959).

The behaviour of an exciton interacting with phonon and with hoton fields are discussed for the cases of weak and strong limits f these interactions, with simplifying assumptions on the electronic tructures of an exciton. After a review of the general features of he motion of an exciton in a phonon field, a discussion is given how hese features manifest themselves in the line-shape of an exciton bsorption band. A tentative explanation of the Urbach rule on the ail part of fundamental absorption is presented. A brief survey is iven of Hopfield's work on the exciton-photon interaction (Abstr. 419 of 1959) with particular emphasis on the desirability of general bsorption and dispersion formulae for the case where neither xciton—photon interaction nor exciton—phonon (or any other dissiative) interaction is small. Hopfield's result is then applied to direct) radiative annihilation of an exciton, and the second-order erturbation theory to indirect radiative annihilation. Dissociation f an exciton in phonon field as well as non-radiative recombination into an exciton) and radiative annihilation of a free electron—hole air is also discussed. The photoconductivity and luminescence of n exciton is briefly considered.

948 THE INFLUENCE OF THE DISCRETE STRUCTURE OF A CRYSTAL ON THE ENERGY, EFFECTIVE MASS, AND DISPERSION LAW OF A POLARON.
S.M.Genkina and K.B.Tolpŷgo.

Fiz. tverdogo Tela (USSR), Vol. 2, No. 10, 2400-10 (Oct., 1960). In Russian.

The variational principle is applied to wave-functions chosen on the effective mass approximation. If it is assumed that the radius of the polaron $r_{qu} \gg a$ (the lattice constant), the characteristic frequencies of the phonons can be expressed as a power series in ax, where x is the wave-vector. The radius and energy of polarons are found as a function of velocity. The results differ from the continuous theory by an amount which increases with effective mass. A numerical calculation for NaCl shows deviations from the "limiting long-wave" approximation for $r_{qu} \lesssim 3a$. [English translation in: Soviet Physics—Solid State (USA)].

M.G.Priestley

949 EXPERIMENTAL INVESTIGATION OF THE POLARON. MEASUREMENT OF THE ELECTRON MOBILITY IN AgCl AND AgBr.
L.Chollet and J.Rossel.

Helv. phys. Acta (Switzerland), Vol. 33, No. 6-7, 627-56 (1960). In French.

Electron mobility in these crystals was investigated using a pulsed X-ray technique in a range of temperatures where comparison with existing polaron theories is possible. Special attention was iven to the measurement of true microscopic mobility by selecting crystals where trapping and multiple trapping effects are negligible The main results can be summarized as follows: AgBr has better counting properties than AgCl but in both cases surface effects play an important role and too strong irradiation can stop the sensitivity In neither case could hole motion be observed. The characteristic exponential law for μ (T) given by optical mode scattering was confirmed and the corresponding experimental Debye temperature s in good accord with the predicted value. The reduction of mobility observed below ~100°K can be accounted for by ionized mpurity collisions but is not easily compatible with a law of the ype $\mu \sim T^{+3/2}$. Values for the polaron mass were derived using oth the Lee—Low—Pines and the Feynmann—Schultz theories.

950 POLARON MOBILITY IN POTASSIUM BROMIDE.
M.Onuki and H.Kawamura.

. Phys. Soc, Japan, Vol. 14, No. 7, 967-8 (July, 1959).

The polaron mobility is measured as a function of temperature, nd the effective masses of the conduction electrons and polarons re obtained by fitting theoretical predictions. K.G.Major

951 PROBABILITY DENSITY OF ELECTRON SEPARATION IN A UNIFORM ELECTRON GAS.
.H.March and W.H.Young.

hil. Mag. (Eighth Ser.) (GB), Vol. 4, 384-9 (March, 1959).

It is shown by means of the virial theorem that the total energy f a gas of N electrons may be expressed in terms of $F_2(\xi_{12})$, the probability density of separation ξ_{12} between electrons; F_2 is related to a first-order density matrix for N—1 particles. In order to investigate the form of F_2 it is proposed that suitable density matrices be formed from localized orbitals centred on definite lattice sites. This has been carried out in the case of a gas of low density, when the method should be accurate, and the form of $F_2(\xi)$ is plotted for this case. Extensions to the high-density and intermediate-density ranges are discussed. D.M.Edwards

952 MOMENTUM DISTRIBUTION OF AN INTERACTING ELECTRON GAS.
E.Daniel and S.H.Vosko.

Phys. Rev. (USA), Vol. 120, No. 6, 2041-4 (Dec. 15, 1960).

The momentum distribution of an interacting electron gas at zero temperature is studied in the high-density region. Numerical computations are made for the graphs corresponding to the excitation of pairs, which are known to be equivalent to the random phase approximation of Bohm and Pines. Exchange graphs are discussed. The numerical results, extrapolated to actual electronic densities in metals, show that a large discontinuity in the momentum distribution still remains at the Fermi level.

953 A DENSITY MATRIX APPROACH TO CORRELATION IN A UNIFORM ELECTRON GAS.
W.H.Young and N.H.Harris.

Proc. Roy. Soc. A (GB), Vol. 256, 62-80 (May 31, 1960).

The energy of a uniform electron gas can be specified completely in terms of its second-order density matrix. Mayer (Abstr. 1498 of 1956) has therefore suggested that trial matrices satisfying all the usual conditions might be employed to determine variationally correlation energies and pair functions. Unfortunately, the particular choice made by Mayer did not satisfy all the Pauli conditions on the second-order matrix. However, matrices satisfactory from this point of view are presented here and the consequences of assuming such forms are investigated. Since one of the matrices is a direct generalization of the Hartree—Fock expression, a description of correlation effects is assured and it appears that this should be adequate for all densities.

954 MOMENTUM DISTRIBUTIONS OF PHOTONS FROM POSITRONS ANNIHILATING IN ALKALI HALIDES.
A.T.Stewart and N.K.Pope.

Phys. Rev. (USA), Vol. 120, No. 6, 2033-41 (Dec. 15, 1960).

The angular correlation of photons from the two-gamma decay of positrons in all sodium halides and all alkali chlorides was measured. The data yields the momentum distribution of the two gamma-rays which is also the momentum distribution of the annihilating electron—positron pairs. It is seen that the positive ion has very little influence on the momentum distribution in comparison with the negative ion. These distributions in momentum are compared with the distributions calculated from various models of electron and positron wave-functions in the crystal. For fluorides and chlorides, the electron—positron wave-function products which yield fits to the experimental data resemble Hartree—Fock free-ion electron wave-functions. Both the wave-function products and the free-ion wave-functions yield density distributions which are similar to the electron densities obtained by X-ray measurements. This conclusion makes improbable a model of single-particle wave-functions describing both the electrons and the positron tightly bound to the negative ion.

DEFECT PROPERTIES

955 THE EXPERIMENTAL STUDY OF CYCLOTRON RESONANCE IN METALS.
M.Ya.Azbel and E.A.Kaner.

Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 1(7), 80-7 (July, 1960). In Russian.

Recent experimental results on cyclotron resonance in metals are discussed and compared with the theoretical predictions. It is emphasized that before line shapes can be compared with theory the magnetic field must be accurately parallel to the surface of the metal. The validity of measuring dR(H)/dH and not R(H) (the surface resistance) is discussed and a method of using the separation of the maxima and minima of dR(H)/dH to determine whether the measured effective mass is a maximum or a minimum is suggested. It is shown that the oscillations in R(H) and dR(H)/dH have the same amplitude only for a quadratic dispersion law; otherwise the oscillations in dR(H)/dH are much more prominent. [English translation in: Soviet Physics–JETP (USA)]. M.G.Priestley

956 LATTICE DEFECTS AND THE MECHANICAL PROPERTIES OF SOLIDS. B.A.Bilby.

Nature (GB), Vol. 188, 713-15 (Nov. 26, 1960).

Report of the second symposium of the Fifth Congress of the International Union of Crystallography, held at Cambridge, 1960. The symposium was on 22 July-4 Aug. About 100 papers were presented, grouped under twelve main headings as follows: yield strength, work-hardening, stacking faults, twinning, fracture, fatigue, dislocations and point defects, radiation damage, recrystallization, alloy hardening, martensitic transformations.

957 THE EFFECT OF LATTICE DISTORTION AROUND POINT DEFECTS ON THE SCATTERING OF LONG-WAVELENGTH NEUTRONS. D.G.Martin.

Phil. Mag. (Eighth Ser.)(GB), Vol. 5, 1235-46 (Dec., 1960).

In a crystalline element the scattering of long-wavelength neutrons by a point defect and an atom are known to be identical. However, when lattice distortion around the point defect is also considered, this is no longer true; in particular the scattering of a point defect is now anisotropic and varies with wavelength. An expression for the cross-section of a defect in a relaxed lattice was derived and applied to f.c.c. and b.c.c. lattices, and in greater detail to copper and molybdenum where the magnitude of the relaxation around defects is known. It was found that the scattering cross-section was appreaciably altered by the relaxation of the surrounding atoms, and in particular from those that are nearest neighbours to the defect. A neglect of this relaxation in the interpretation of a neutron scattering experiment could lead to an error of an order of magnitude in an estimate of the number of defects. Also a study of the variation in cross-section with wavelength or scattering angle, which was analogous to an X-ray small-angle scattering experiment, is incapable of determining uniquely the size of defect agglomerates in solids. However, under favourable circumstances, such experiments could become a useful technique for estimating the lattice distortion around defects.

958 ON THE PROBLEM OF DETERMINATION OF THE DENSITY, ENERGY OF FORMATION, AND ACTIVATION ENERGY FOR MOVEMENT OF THERMALLY-INDUCED VACANCIES FROM THE DILATOMETRIC MEASUREMENTS.

S.D.Gertsriken, N.N.Novikov and B.F.Slyusar.

Fiz. Metallov i Metallovedenie (USSR), Vol. 9, No. 3, 465-7 (March, 1960). In Russian.

In dilatometric studies of the concentration of thermally induced vacancies and the energy of their formation, use has been made of the formula $\Delta V/V = 3\Delta l/l$, where $\Delta V/V$ is the relative change of volume due to the change in the concentration of the vacancies, Δl is the change in length of the specimen, and l its original length. Since the validity of this formula for specimens other than of cubic shape has been questioned by Lazarev et al. [Fiz. Metallov i Metallovedenie, Vol. 8, No. 7, 154 (1959)], arguments, based on published experimental data, are brought forward to repudiate this view. M.H.Sloboda

959 EFFECT OF VACANCY CONDENSATION ON THE CORROSION SUSCEPTIBILITY OF SUBGRAIN BOUNDARIES IN ALUMINUM. O.P.Arora and M.Metzger.

Acta metallurgica [Internat.], Vol. 8, No. 1, 49-52 (Jan., 1960).

Enhanced corrosion susceptibility of subgrain boundaries was found in pure Al which was slowly cooled from high temperatures, but not in quenched material. The effect is attributed to thermal vacancies, which produce jogs in dislocation lines during cooling. These jogs reduce the protective effect of the surface oxide film where the dislocation lines meet the surface. H.Mykura

960 ON THE QUENCHING OF VACANCIES IN A FINE-GRAINED POLYCRYSTAL. A.Blandin and J.Friedel.

Acta metallurgica (Internat.), Vol. 8, No. 6, 384-7 (June, 1960). In French.

When quenched vacancies disappear preferentially at the outside surface or at grain boundaries, the measured resistance should decrease exponentially with time, after a few minutes. The time constant varies with the dimensions of the grains and gives an absolute value of the diffusion constant $D = D_0 \exp(-U/kT)$ of the vacancies. This analysis should be valid for fine grains and quenches from moderate temperatures. These conditions seem to be fulfilled in recent experiments by Germagnoli et al. leading to $D_0 \cong 5$ c.g.s. with U = 1.3 eV for copper and $D_0 \cong 15$ c.g.s. with U = 1.5 eV for platinum.

961 ON THE INTERPRETATION OF QUENCHING EXPERIMENTS ON GOLD. G.Schottky.

Z. Phys. (Germany), Vol. 160, No. 1, 16-32 (1960). In German.

When a metal contains single vacancies, bivacancies and trivacancies in non-equilibrium concentrations, mutual interactions of the vacancies occur. Equations for the rates of these reactions are set up, and it is shown that only the most stable of the forms of trivacancy need be considered. When the various vacancy complexes are in equilibrium, the measured diffusion constant is a mean of the individual values. The measured activation energy however is not the mean of the individual values, but depends also on the binding energies. A complete interpretation of the available quenching experiments on gold has not yet been possible. But it is concluded that the various types of vacancy complex are in equilibrium with each other during the annealing process and that the energy of movement of the bivacancy can be only negligibly smaller than 0.6 eV. The hypothesis of a short range repulsion between single vacancies is unnecessary. H.Mykura

962 INTERSTITIAL ATOMS IN COLD WORKED ALUMINUM. M.E.Straumanis and T.Ejima.

Acta metallurgica (Internat.), Vol. 8, No. 1, 56-7 (Jan., 1960).

The slightly higher density of cold worked wires to recrystallized ones was investigated and assumed to be caused by atoms forced into interstitial positions during cold work. They leave these positions upon reception of some energy (recovery of Al). The results are tabulated.

963 IMPERFECTIONS, LATTICE CONSTANTS AND DENSITIES OF COLD-DRAWN AND OF RECRYSTALLIZED ALUMINIUM WIRES. M.E.Straumanis and T.Ejima.

Nuovo Cimento (Italy), Vol. 18, No. 1, 48-64 (Oct. 1, 1960).

Aluminium contains in lesser or larger amounts excess atoms, depending on the kind of mechanical or thermal treatment and on the concentration of trace impurities. The number of excess atoms in a 99.9% pure recrystallized Al wire is 18 per 10 000 unit cells, and they may be a constituent of the denser segregations. The lattice constant of a cold drawn Al wire in the direction of its axis was slightly smaller (a_{25} = 4.049 44) than that of the recrystallized wire (a_{25} = 4.049 47 A), but was larger in the transverse direction (a_{25} = 4 049 53 A). The thermal expansion coefficient of the recrystallized wire ($\alpha = 22.9 \times 10^{-6}$) between 10 and 60° C did not differ (significantly) from that of the hard drawn wires. The density of the whole hard wire was d_{25} = 2.700 4 g/cm^3 (core –2.698 9), that of the recrystallized wire was smaller (2.699 3 g/cm^3). The concentration of interstitials was largest in the outside layers of the wire (at leas 4 atoms per 1 000 unit cells or 1.5×10^{13} atoms per cm^2). Previous measurements, giving lower densities for cold worked metals, may be explained by the fact that crack and capillary formation during cold work frequently outbalance the effect of density increase due to increase of interstitial atom (blocking dislocation) concentration, created by the process of slipping and deformation. Strain hardenin appears then as a consequence of the increasing number of interstit atoms. The latter processes are in agreement with the theories as discussed by Schmid and Boas. From the density decrease of the hard wire (after heating) the volume of submicroscopic fissures pe cm^3 was estimated: 10^{-4} cm^3. They may be created by moving dislocations and vacancies (formation of dislocation cracks), during the deformation process Only both lattice constant and density measurements of the same material give a correct picture of conditions ins (in terms of n') of a deformed as well as of a recrystallized metal or another crystalline material.

964 LOW TEMPERATURE ANNEALING STAGES OF IRRADIATED COPPER. R.R.Hasiguti.

Proc. Japan Acad., Vol. 36, No. 6, 335-9 (June, 1960).

A theoretical discussion of the annealing stages, giving special attention to interstitial-impurity interactions. H.Mykur

MOVEMENT OF POINT DEFECTS DURING FATIGUE OF ALUMINIUM CRYSTALS. See Abstr. 21121 of 1960.

965 THE INTERACTION OF DISLOCATIONS WITH BOUNDARIES AND SURFACE FILMS. A.K.Head.

Austral. J. Phys., Vol. 13, No. 2a, 278-83 (July, 1960).

Solid State Physics Conference (see Abstr. 17864 of 1960). A digital-computer programme for finding the equilibrium positions o a group of dislocations was applied to two problems of a different type from those considered previously. These are: (i) An infinite solid has different shear moduli on either side of a plane boundary On the side with lower modulus a group of dislocations are on a sli plane which is perpendicular to the boundary. They are forced owards the boundary by an applied stress but repelled from the oundary by the change in modulus. (ii) On the plane face of a semi-nfinite solid is a film with shear modulus greater than that of the ulk. A group of dislocations are on a slip plane which is perpendi-ular to the film. The applied stress necessary to force the leading islocation into the film is found in two particular cases which orrespond to a rhodium film on silver or to the oxide film on luminium.

966 DISLOCATION SOURCES IN QUENCHED ALUMINIUM-BASED ALLOYS.

K.H.Westmacott, D.Hull, R.S.Barnes and R.E.Smallman.
Phil. Mag. (GB) (Eighth Ser.), Vol. 4, 1089-92 (Sept., 1959).

Electron microscope observations were made on a series of alloys from each of the systems Al–Ag, Al–Si, Al–Cu and Al–Mg; n all cases foils 0.001 in. thick were used and quenched from homo-geneous solid solution into various quenching media. The experi-ments showed that in any given alloy system the formation of helical dislocations was favoured by lowering the quenching rate or by in-creasing the solute concentration. Also the formation of helices was promoted in those alloys with the greatest lattice misfit in the alum-inium matrix. Evidence was found for the operation of Frank–Read sources from dislocation loops created by the condensation of vacancies. R.Bullough

967 THE GROWTH OF PRISMATIC DISLOCATION LOOPS DURING ANNEALING. C.A.Johnson.

Phil. Mag. (Eighth Ser.)(GB), Vol. 5, 1255-65 (Dec., 1960).

Recent observations of the growth of quenched-in dislocation oops during annealing are discussed. A mechanism for the coales-cence of loops is proposed. The mechanism depends on short-circuit diffusion around the periphery of prismatic dislocation oops. This mechanism is contrasted with the theory of loop coalescence by vacancy diffusion through the matrix. It is shown hat the experimental observations are in better accord with the short-circuit diffusion theory. Interpretation of the experimental observations on the basis of the short-circuit mechanism leads to a value for the activation energy for diffusion along a dislocation ine. For aluminium this value is calculated to be 0.7 eV.

968 ELECTRON THEORETICAL INVESTIGATIONS OF DEFECTS IN METALS. IX. THE ELECTRICAL RESISTANCE OF EDGE DISLOCATIONS. A.Seeger and H.Bross.

Z. Naturforsch. (Germany), Vol. 15a, No. 8, 663-89 (Aug., 1960).
In German.

The electrical resistance of a metal at an edge dislocation is calculated from non-linear elasticity theory and the relation bet-ween potential and dilatation. Theoretical calculations are com-pared with experimental results obtained with Cu. J.Franks

969 ELECTRON OPTICAL STUDY OF BASAL DISLOCATIONS IN GRAPHITE. S.Amelinckx and P.Delavignette.

J. appl. Phys. (USA), Vol. 31, No. 12, 2126-35 (Dec., 1960).

Dislocations having a Burgers vector in the basal plane and ying in this plane, have been studied in graphite by the use of thin oil transmission electron microscopy. The dislocations are disso-iated into ribbons consisting of two partials separated by a stacking ault. Specific models for these dislocations are presented. Hexa-gonal networks contain extended and contracted nodes. The presence of two types of stacking faults give rise to singularities which are analysed in terms of experimentally determined Burgers vectors. The dislocations and even the networks are very mobile along the basal plane. The stacking fault energy is determined as 3 to $\times 10^{-2}$ ergs/cm^2.

970 OBSERVATIONS OF DISLOCATIONS IN METALS BY TRANSMISSION ELECTRON MICROSCOPY. P.B.Hirsch.

. Inst. Metals (GB), Vol. 87, Pt 12, 406-18 (Aug., 1959).

This paper reviews the results obtained so far from studies nvolving direct observation of dislocations in metals by trans-mission electron microscopy. The technique was used to study oth fundamental properties of dislocations and the distribution of efects as a function of treatment of the specimens. The former ategory includes observations on glide, partial dislocations, tacking faults, cross-slip, dislocation interactions and nodes, low-ngle boundaries, interactions between point defects and dislocations, limb, and dislocation sources. The latter class includes results on istributions of dislocations and dislocation loops in specimens eformed in tension or in fatigue, after recovery or recrystallization, uenching, and radiation damage. Some suggestions are made as to he probable trends of future applications of this technique.

971 ELECTRON MICROSCOPE STUDIES OF DISLOCATION STRUCTURES IN GRAPHITE. G.K.Williamson.

Proc. Roy. Soc. A (GB), Vol. 257, 457-63 (Sept. 27, 1960).

Dislocations in a variety of single-crystal flakes of graphite (hexagonal crystal structure) were studied by transmission electron microscopy. All the dislocations observed are parallel to to the layer plane with Burgers vectors in this plane. Dislocations occurred as pairs, approximately 1000 A apart, with Burgers vectors of the type $\frac{1}{3}a\langle 1010\rangle$ giving together a unit lattice translation of a along one of the three coplanar hexagonal axes. The area between these two partials contained a stacking fault corresponding to the rhombohedral structure discussed by Lipson and Stokes (1942). The stacking fault energy was shown to be ~ 0.1 erg/cm^2 and to be substantially independent of temperature up to 900°C. Two interactions were observed; one was a direct one to form a network with extended and contracted nodes and the other an indirect one between disloca-tions on different slip planes and due to the long-range stress fields of the dislocations. An assymmetry observed in the latter interac-tion can be explained by the different line tensions of edge and screw dislocations. All dislocations are glissile and no interaction leading to sessile dislocations found.

972 SOME PHENOMENA OBSERVED ON DEFORMING SINGLE CRYSTALS OF ANTIMONY.

L.M.Soifer and V.I.Startsev.
Dokl. Akad. Nauk SSSR, Vol. 134, No. 4, 795-8 (Oct. 1, 1960).
In Russian

Dislocations on the (111) cleavage plane of single-crystal anti-mony plates were revealed by selective etching in dilute nitric acid. Twinning was produced in the crystal layers by bending in the opposite direction. Photographs of etched crystals are reproduced showing that residual dislocations remain after detwinning, that a dislocation line may pass through a grain boundary, and that slip, as well as twinning, occurs on deforming antimony crystals of the 99.5% purity used in these experiments. R.F.S.Hearmon

973 ETCH PITS AND DISLOCATIONS IN ICE CRYSTALS. G.W.Bryant and B.J.Mason.

Phil. Mag. (Eighth Ser.)(GB), Vol. 5, 1221-7 (Dec., 1960).

Etching of ice crystals grown from both the vapour and the melt revealed etch pits in concentrations of up to 10^6/cm^2 which apparently mark the sites of emergent dislocations. Silvered Formvar replicas show the etch pits on the basal surface to be hexagonal pyramids on which spiral or closed terraces of steps are often visible. These features are interpreted in terms of the etching of helical dislocations. The etch pits tend to group them-selves along low-angle grain boundaries and slip lines. When the crystal is mechanically stressed, etch channels appear on the basal plane along the $\langle 1120\rangle$ directions which suggests that these are the preferred glide directions. Double rows of small etch pits radiat-ing from impurity specks and local centres of high stress probably mark the sites of dislocation loops intersecting the surface. Pyra-midal hillocks appearing in concentrations of 10^5/cm^2 on the basal faces of crystals grown from the vapour may be growth features and not the result of etching.

974 CRYSTAL DISLOCATIONS AND THE GROWTH OF ETCH PITS. W.Riessler.

Z. angew. Phys. (Germany), Vol. 12, No. 10, 433-42 (Oct., 1960).
In German.

A comparison of the effect of different etches on the (100), (111) and (110) planes of germanium with a discussion of the effect of anisotropic etching rates and impurities on the shape and fine struc-ture of the etch pits. J.E.Caffyn

975 STACKING FAULTS IN COPPER–NICKEL ALLOYS. K.Nakajima.

J. Phys. Soc. Japan, Vol. 14, No. 12, 1825-6 (Dec., 1959).

Based on X-ray diffraction patterns of heavily deformed alloy powder particles, curves showing the concentration dependence of stacking fault probability α, density of dislocations ρ, and stacking fault energy γ, were constructed for the Cu–Ni system. Both α and ρ passed through a maximum at the 50–50 composition, whereas γ increased rapidly as the Ni content in the alloy increased above 50%. The results are discussed in the frame of Suzuki's theory on the thermodynamical equilibrium in the faulted layer and in terms of the possible effect of inhomogeneity of the structure on small-angle scattering. M.H.Sloboda

976 ORDER AND DISORDER. I. THEORY OF STACKING FAULTS AND DIFFRACTION MAXIMA. H.D.Megaw.

Proc. Roy. Soc. A (GB), Vol. 259, 59-78 (Nov. 22, 1960).

From formal postulates about a three-dimensional set of stacking faults, expressions are derived giving the intensity as a function of direction in reciprocal space, and from these the position, breadth and heights of the maxima are obtained in terms of the fault probability and slip vector. (The mechanism of the faulting is unspecified; it may be due to annealing rather than actual slip). It is shown that random faulting only gives reasonably strong sharp maxima when the displacements from Bragg maxima are fairly small, in which case the positions (though not the heights or breadths) are nearly the same as for regular faulting. The nature of the faults in direct space is considered, and the treatment is illustrated by considering (i) a hypothetical faulted structure, (ii) the intermediate plagioclase felspars.

977 OBSERVATION OF A PECULIAR TYPE OF DOMAIN STRUCTURE OF TRICLINIC TUNGSTEN TRIOXIDE.

S.Tanisaki.

J. Phys. Soc. Japan, Vol. 14, No. 7, 970-1 (July, 1959).

Normal domains had walls of (010) twin planes (Abstr. 18375 of 1960). Pressure along the b-axis caused reversal of the a- and b-axes and a domain structure with walls of (100) planes over part of the crystal. D.G.Holloway

978 VOLUME AND STRUCTURAL CHANGES DURING HEATING OF COLD-WORKED ELECTRODEPOSITED AND REMELTED NICKEL.

S.D.Gertsriken, L.N.Larikov and N.N.Novikov.

Fiz. Metallov i Metallovedenie (USSR), Vol. 9, No. 3, 478-80 (March, 1960). In Russian.

Specimens of both electrodeposited and vacuum-melted Ni, subjected to preliminary cold deformation (by drawing or torsion), were heated slowly to approximately 550°C, and the structural changes taking place during this treatment were studied by dilatometric and X-ray diffraction measurements. The fact that the recovery and recrystallization processes were more clearly reflected in the volume changes of electrodeposited Ni was attributed to a higher content of gaseous impurities (mainly H) in this material. The absence of well defined deflection points on dilatometric curves for specimens, deformed in torsion, resulted from non-uniform character of recovery and recrystallization of non-uniformly deformed metal. M.H.Sloboda

Diffusion

979 THE DIFFUSION OF ANTIMONY AND SILVER.

H.Fonfara.

Ann. Phys. (Germany), Vol. 7, No. 1-2, 66-70 (1960). In German.

Reports measurements of the irreversible increase of resistivity of Ag layers, due to diffusion of Sb, at temperatures between 70° and 105°C. Results can be interpreted through the diffusion coefficient (RT in calories):

$$D = 3.5 \times 10^4 \exp(-34\,100/RT) \text{ cm}^2/\text{sec}$$

L.Pincherle

980 A DISCUSSION OF "SELF-DIFFUSION AND INTER-DIFFUSION IN GOLD NICKEL ALLOYS": A CORRELATION WITH ABSOLUTE RATE THEORY.

R.W.Armstrong, J.P.Hirth and G.M.Pound.

Acta metallurgica (Internat.), Vol. 8, No. 1, 55-6 (Jan., 1960).

Values of the activity coefficients of activated species of Au and Ni were evaluated using experimental data for the self (radioactive) diffusion coefficient and for the activity coefficient of the normal species. J.Thewlis

981 THE EFFECT OF SEGREGATION ON THE SOLUTE DIFFUSION ENHANCEMENT DUE TO THE PRESENCE OF DISLOCATIONS. A.J.Mortlock.

Acta. metallurgica (Internat.), Vol. 8, No. 2, 132-4 (Feb., 1960).

The enhancement of solute diffusion coefficients due to short circuiting along dislocation pipes in binary alloys is discussed and shown to be greater than would be expected on the basis of Hart's [Acta metallurgica, Vol. 5, 597 (1957)] theory of the effect in pure metals. R.F.Peart

982 DIFFUSION IN THE URANIUM—TITANIUM SYSTEMS.

Y.Adda and J. Philibert.

Acta metallurgica (Internat.), Vol. 8, No. 10, 700-10 (Oct., 1960). In French.

The intermetallic diffusion in the system U—Ti was studied between 650 and 1050°C with various techniques: metallography, microhardness and the Castaing microanalyser. The diffusion coefficient the frequency factors and the activation energies were determined in the γ phase (centered cubic) for uranium concentrations between 0.05 and 0.9. An important Kirkendall effect was in evidence and the intrinsic diffusion coefficients of U and Ti were calculated on the basis of Darken's relations. These results compared to those previously obtained on the system U—Zr, show that the mobility of Ti atoms is higher than that of Zr atoms. Furthermore, the vacancies supersaturation due to the Kirkendall effect was evaluated in order to explain the difference in porosity observed in the coupled U—Zr and U—Ti. Values very near 10^{-3} were found for these two couples. It is concluded that the difference in porosity is due to different conditions of nucleation.

983 THE EFFECT OF PLASTIC DEFORMATION OF NICKEL ON THE RATE OF DIFFUSION IN THE NICKEL--SULPHUR SYSTEM. B.Ya.Pines and E.F.Chaikovskii.

Fiz. Metallov i Metallovedenie (USSR), Vol. 9, No. 3, 369-73 (March, 1960). In Russian.

The formation of sulphide layers on the surface of polycrystalline Ni in saturated S vapour was studied at 440, 500, and 600°C. The rate of diffusion of S in nickel sulphides increased with increasing degree of the preliminary plastic deformation of Ni, the activation energy for the process decreasing from 19.3 kcal/mol in sulphides, formed on annealed specimens, to 8.9 kcal/mol when Ni, subjected to preliminary deformation of 74%, was used. This effect, more pronounced at lower temperatures, was attributed to the more "defective" crystal lattice of the sulphide layers, formed on plastically deformed Ni with higher free energy.

M.H.Sloboda

984 A MORE PRECISE FORMULATION OF THE THEORY O THE LOCALIZED CHARACTER OF THE CHEMICAL REACTION DURING REACTIVE DIFFUSION IN SOLIDS. I. PARTIA DELOCALIZATION OF THE REACTION IN PHASES OF THE SUBSTITUTIONAL TYPE WITH LINEAR CONCENTRATION GRADIENT

V.I.Arkharov.

Fiz. Metallov i Metallovedenie (USSR), Vol. 9, No. 4, 545-53 (April, 1960). In Russian.

Theoretical. It is postulated that in the course of reactive diffusion, accompanied by the formation of a layer of a phase of the substitutional type with a linear concentration gradient, reaction within the layer of the newly formed phase take place. The number of atoms of either component entering the compound layer at one phase boundary is not equal to that reaching the opposite boundary. Some atoms of a component leave the diffusion current and stay within the compound layer, while others, already present there, are carried away by the diffusion current. In general, the number of atoms participating in these two processes is not equal, the difference representing atoms which take part in the delocalized chemical reaction. The degree of delocalization is determined by the difference between (a) the stoichiometric indices of the components of the compound, (b) the maximum possible deviations from the stoichiometric composition, and (c) the ability of the components to move by the mechanism of both interstitial and substitutional diffusion.

M.H.Sloboda

539.21

985 INTERDIFFUSION OF CHROMIUM AND MOLYBDENUM IN Ni-RICH SOLID α-SOLUTIONS.

B.M.Vasyutinskii and V.S.Kogan.

Fiz. Metallov i Metallovedenie (USSR), Vol. 9, No. 4, 564-8 (April, 1960). In Russian.

Tri-metal specimens, consisting of Mo and Cr films vacuum-deposited on thin (10-15μ) Ni layers, were held for 125 hr at 1250°C, and diffusion of the components was studied by X-ray analysis, metallographic examination, and measurements of microhardness and thermo-e.m.f. None of the properties studied varied acros the diffusion zone in the manner characteristic of a continuous series of solid solution. The σ phase to which the original Ni layer had been converted as a result of diffusion was separated by clearly defined boundaries from the solid solutions layers containing 24-27 at% Cr and 5-8 at% Mo. Since in the course of diffusion-annealing, thickness of these layers increased and their boundaries (indicated by a sudden change in the concentration of the solute atoms) were

isplaced in a manner characteristic of reactive diffusion, it was oncluded that pseudo-reactive diffusion had taken place in the specinens studied. Hence, non-monotonic variation of the solid solubility imit of Ni in α-solution at 1250°C was inferred, and the Mo and Cr orners of the constitution diagram of the Ni–Cr–Mo system were orrespondingly amended.
M.H.Slobona

986 INVESTIGATION OF THE EFFECT OF SMALL SILVER ADDITIONS ON THE COEFFICIENTS OF VOLUME AND BOUNDARY DIFFUSION IN SILVER AND COPPER.
S.D.Gertsriken and A.L.Revo.
Fiz. Metallov i Metallovedenie (USSR), Vol. 9, No. 4, 578-83 (April, 1960). In Russian.

Diffusion of Ag in Cu and in a Cu–Ag alloy, containing 0.1 at % Ag, was studied. The temperature dependence of the diffusion coefficient was determined for both processes. The ratio E_B/E_V, where E_B and E_V are the activation energies for boundary and volume diffusion, respectively, was 0.45 for diffusion of Ag in Cu and 0.51 for diffusion of Ag in the Cu–Ag alloy, the corresponding figure for self-diffusion of pure Ag being 0.44. The width of the grain-boundary layer in both Cu and Cu–Ag alloy was ~ 3000-4000 A. It was established that the activation energy for volume diffusion of Ag in metals such as Ag, Cu, and Al decreases with decreasing atomic number.
M.H.Sloboda

987 STUDYING THE INTERACTION BETWEEN COPPER AND ANTIMONY IN GERMANIUM.
A.Ya.Potemkin and V.I.Potapov.
Fiz. tverdogo Tela (USSR), Vol. 2, No. 8, 1846-8 (Aug., 1960).
In Russian.

The high-temperature mobility of copper was studied in single crystals of both pure germanium and germanium doped with antimany. The method used was that developed by Potemkin et al. (Abstr. 2872 of 1960). It was found that negatively charged copper ions were present. It is concluded that the presence of antimony delays the onset of a measurable copper displacement from 540° to 600° C, thus showing a chemical interaction between copper and germanium below 600° C. [English translation in: Soviet Physics–Solid State (USA)].
M.G.Priestley

988 DIFFUSION OF ANTIMONY IN GERMANIUM ALLOYED WITH ALUMINIUM. I.P.Akimchenko and L.S.Milevskii.
Fiz. tverdogo Tela (USSR), Vol. 2, No. 9, 2109-16 (Sept., 1960).
In Russian.

The diffusion coefficient (D_{Sb}) of antimony in germanium decreased with increase of the aluminium concentration (10^{14}-10^{18} cm^{-3}) beginning at $N_{Al} \cong 5 \times 10^{17}$ cm^{-3}, in qualitative agreement with the vacancy mechanism of diffusion. The dependences of D_{Sb} on aluminium concentration, recorded at various temperatures, were used to explain the observed phenomena in terms of internal electric fields produced by the high concentration gradients of the diffusing impurity. [English translation in: Soviet Physics--Solid State (USA)].
A.Tybulewicz

989 INFLUENCE OF PRESSURE ON THE SELF-DIFFUSION OF SILVER IONS IN SILVER BROMIDE.
A.N.Murin, B.G.Lur'e and N.A.Lebedev.
Fiz. tverdogo Tela (USSR), Vol. 2, No. 10, 2606-11 (Oct., 1960).
In Russian.

Using a radio-isotope exchange technique and a specially designed pressure apparatus, the coefficient of self-diffusion for Ag in AgBr is measured at 1, 1500, 3000, 5500 and 8000 atm and 180°, 220° and 280° C. The correlation factor for the internodal mechanism of diffusion is evaluated from the results. [English translation in: Soviet Physics–Solid State (USA)].
R.F.S.Hearmon

990 HYDROGEN DIFFUSION IN MILD STEELS.
P.K.Foster.
Nature (GB), Vol. 188, 399-400 (Oct. 29, 1960).

The evolution of hydrogen from cylinders of mild steel at 65° C was followed through the changes in pressure in a constant volume burette. The evolution does not follow the simple equations derived from Fick's laws.
D.G.Holloway

Colour Centres

991 THE LOWEST QUANTUM STATE OF CURRENT CARRIERS AND COLOUR CENTRES IN IONIC AND ATOMIC CRYSTALS. V.L.Vinetskii.
Fiz. tverdogo Tela (USSR), Vol. 2, No. 10, 2544-56 (Oct., 1960).
In Russian.

The tight binding approach is used to calculate the ground state, taking into account interaction with optical and acoustic phonons. It is shown that formation of "polar condensons" is energetically favourable. These are classified according to radius and criteria for their existence are discussed. Criteria for macroscopic examination of colour centres are also obtained, taking into account the interaction of the localized electrons with all phonons. [English translation in: Soviet Physics–Solid State (USA)].
M.G.Priestley

992 COLOR CENTERS IN CESIUM HALIDE SINGLE CRYSTALS. P.Avakian and A.Smakula.
Phys. Rev. (USA), Vol. 120, No. 6, 2007-14 (Dec. 15, 1960).

Caesium chloride, bromide, and iodide single crystals were grown from the melt and CsCl crystals also from solution. Coloration was produced by 130 kV X-rays, 3.0 MeV electrons, and by electrolysis. In CsI coloration resulted from electrolysis only. The absorption of uncoloured and coloured crystals was measured from 0.175 to 3.5 μ at 25°, −78°, and −190° C. After coloration all three crystals showed one strong band in the visible (near infrared for CsI) and several weaker bands at shorter and longer wavelengths, which shifted with temperature change. The spectral positions in mμ for a number of the bands at −190° C are:

	λ_1	λ_2	λ_3	λ_4	λ_5	λ_6	λ_7	λ_8	λ_9	λ_{10}
CsCl	227		270	370	430	579	715	780	855	980
CsBr	241	~270	~315	390	480	646	(780)	840	(~930)	1055
CsI	270	330		425	535	750			1050	1185

The strongest band (λ_6) behaves similarly to the F-band in the NaCl-type alkali halides. The half-width of the band (0.20 to 0.23 eV at −190° C) and its increase with temperature, the shifting of the band maximum toward longer wavelengths upon warming to room temperature (by ~0.08 eV), and the conversion by bleaching with light into other bands support the assignment of this band as the F-band. The spectral position of the band maximum approximately follows the Mollwo relation (λ_{max} = const d^n, where d = interionic distance and n = 2.5). Bleaching experiments suggest the assignment of the band λ_{10} as the M-band and the bands between the F and M-bands as R-bands. The origin of the ultraviolet bands are still uncertain.

993 ALPHA AND BETA BANDS IN KCl AND NaCl.
G.Chairotti, G.Giuliani and D.W.Lynch.
Nuovo Cimento (Italy), Vol. 17, No. 6, 989-90 (Sept. 16, 1960).

Alpha and beta bands were observed in thin cleared specimens giving peaks for KCl at 1770 and 1664 A respectively and for NaCl at 1743 and 1682 A respectively. Additive coloration produced only the beta band which is bleached by F-light at 95° K the alpha band then growing. In X-ray coloured KCl crystals the alpha band bleaches thermally in the region 120-150° K. Predictions of structure in the beta band, due to splitting, for NaCl were not confirmed.
G.F.J.Garlick

994 THE ENERGY OF THERMAL DISSOCIATION OF F-CENTRES IN KCl.
L.M.Shamovskii, A.A.Dunina and M.I.Gosteva.
Fiz. tverdogo Tela (USSR), Vol. 2, No. 10, 2526-35 (Oct., 1960).
In Russian.

The electrical conductivity was measured of additively coloured crystals with F-centre concentrations large compared with the concentration of equilibrium structural defects. From the conductivity versus 1/T curves, the dissociation energy derived is 2.05 eV, which is in good agreement with the calculated value. The mobility at 673° K is ~40 cm^2 V^{-1} sec^{-1}. [English translation in: Soviet Physics – Solid State (USA)].
R.Berman

995 F-CENTERS IN LiCl CRYSTALS.
K.Fukuda, H.Matsumoto and A.Okuda.
J. Phys. Soc. Japan, Vol. 14, No. 7, 969 (July, 1959).

Optical absorption and electron spin resonance spectra were measured for X-ray and γ-ray irradiated crystals at room temperature. Only F-band optical absorption appeared to be present and only F-centre resonance, with a g-value of 1.997 ± 0.002, was found. Using a value of unity for the oscillator strength, Smakula's formula gives an F-centre density of 10^{18} cm^{-3}. G.F.J.Garlick

996 FORMATION OF F CENTERS IN KCl BY X-RAYS.
P.V.Mitchell, D.A.Wiegand and R.Smoluchowski.
Phys. Rev. (USA), Vol. 121, No. 2, 484-98 (Jan. 15, 1961).

Measurements were made of the growth of the F-band in undeformed, deformed, and heat-treated KCl crystals at room temperature using 140 kVp X-ray irradiation. The growth curves were analysed in terms of the initial concentration of negative-ion vacancies in the lattice before irradiation, rate of formation of new vacancies, rate of electron capture by the initial and by the new vacancies, and bleaching constants. These parameters were studied as a function of the intensity of irradiation. It appears that the new vacancies are generated at a rate proportional to the square of the intensity of irradiation and inversely proportional to the dislocation density. Deformation increases the concentration of initial vacancies near dislocations, while heat treatment increases the concentration of initial vacancies dispersed in the volume of the crystal. Since neither the jog mechanism nor the Varley mechanism can account for the observations, a new model is proposed which accounts for all the observed phenomena.

997 DEFECT INTERACTIONS IN IRRADIATED CALCIUM-DOPED POTASSIUM CHLORIDE.
J.H.Crawford, Jr and C.M.Nelson.
Phys. Rev. Letters (USA), Vol. 5, No. 7, 314-15 (Oct. 1, 1960).

Study of the thermal bleaching of the 325 mμ band associated with Cl_2^- centres (produced by X-rays) in KCl:Ca shows that it disappears at ~ −40°C. At 195°K, F-band irradiation releases electrons and the reverse process occurs, enhancing the 325 mμ band. The results support the theory of enhancement of F-centre formation by the action of isolated cation vacancies converted to Cl_2^- and anion vacancies. G.F.J.Garlick

998 THEORY OF THE F CENTRE. I. WAVE-FUNCTIONS AND EIGENVALUES FOR DYNAMIC ELECTRON-LATTICE COUPLING. M.Wagner.
Z. Naturforsch. (Germany), Vol. 15a, No. 10, 889-908 (Oct., 1960). In German.

A treatment of the coupling of defects to the matrix crystal lattice is attempted. The electron—lattice coupling for F-centres is reduced to a two-oscillator problem with the symmetry of both electron wave-functions for the centre. G.F.J.Garlick

999 THERMAL STABILITY OF THE R, N AND M CENTRES AND THE OSCILLATOR STRENGTH OF THE M BAND OF KCl CRYSTAL. T.Tomiki.
J. Phys. Soc. Japan, Vol. 14, No. 8, 1114 (Aug., 1959).

Oscillator strengths for the M-band relative to the F-band as previously determined (Abstr. 10233 of 1959) are in error because of other transformations present than F → M on irradiation with F-light. Crystals with only F- and M-centres are prepared by thermal bleaching of other centres formed in irradiation and data on these show that two F-centres are needed to produce one M-centre, the latter having an oscillator strength of 0.5. G.F.J.Garlick

1000 A QUANTITATIVE STUDY OF THE M CENTRE IN KCl.
T.Tomiki.
J. Phys. Soc. Japan, Vol. 14, No. 9, 1243 (Sept., 1959).

Experimental results on the relation between F and M centres (see preceding abstract) are explained by assuming that the second M-centre absorption band coincides with the peak of the F-band. The half-width of the second band is then 0.08 eV at room temperature. J.Franks

Radiation Effects

1001 THE EFFECT OF α-PARTICLES AND X-RAYS ON COLOURED ROCKSALT. H.Adler.
Acta phys. Austriaca, Vol. 13, No. 4, 369-86 (1960). In German.

Bleaching of R-centres in natural coloured rocksalt with α-particles and X-rays is investigated and possible processes responsible for their instability are discussed. J.E.Caffyn

1002 THE NATURE OF RADIATION-INDUCED POINT-DEFECT CLUSTERS. R.S.Barnes and D.J.Mazey.
Phil. Mag. (Eighth Ser.)(GB), Vol. 5, 1247-55 (Dec., 1960).

The electron microscope was used to examine point-defect clusters produced in copper and aluminium foils bombarded with 1.4×10^{17} alpha-particles cm^{-2}. The foils were bombarded as a stack and, in copper, both those through which the alpha-particles had passed and that in which they came to rest appeared similar, containing dislocation loops (r ~ 200 A) and a background of more numerous and smaller dots (r ~ 20 A). The behaviour at grain boundaries suggested that these two type of cluster were due to different point defects. Whereas the dislocation loops normally annealed out at about 350°C, in the foil in which the alpha-particles came to rest (containing ~10^{18} atoms of helium cm^{-2}) they grew to form a dislocation tangle, and eventually small helium bubbles (r ~ 40 A) appeared in the same number at the original small dots. The results indicate that the dislocation loops are due to the clustering of interstitial atoms and the small dots are clusters formed from vacancies. It is also inferred that the helium atoms are in interstitial positions during the bombardment, and form bubbles by nucleating upon the clusters.

1003 ANNEALING KINETICS OF NEUTRON-IRRADIATED ALUMINIUM AND COPPER.
T.H.Blewitt, R.R.Coltman and C.E.Klabunde.
Austral. J. Phys., Vol. 13, No. 2a, 347-53 (July, 1960).

Solid State Physics Conference (see Abstr. 17864 of 1960). Activation energies for the annealing of copper and aluminium following reactor bombardment near 4°K were measured in the range from 10 to 40°K. Both the change-in-slope method and the isothermal-technique method were utilized with the assumption that a constant activation energy existed. Computations of the number of jumps involved from the measured activation energy result in an impossibly small number. It is obvious that the method for determination of the activation energies is not applicable, probably because of the non-uniqueness of the activation energy.

1004 IRRADIATION HARDENING IN COPPER AND NICKEL.
M.J.Makin and F.J.Minter.
Acta metallurgica (Internat.), Vol. 8, No. 10, 691-9 (Oct., 1960).

The lattice and dislocation components of irradiation hardening have been measured in polycrystalline copper and nickel as a function of (a) testing temperature and (b) neutron dose. The results are compared with Seeger's theory of lattice hardening, which is based on dislocations cutting through a forest of obstacles under the action of both stress and thermal activation. The observed temperature dependence of the lattice hardening in both metals is in excellent agreement with the theory in the as-irradiated condition. Mild annealing treatments greatly reduce the temperature sensitivity however and the theory is no longer obeyed. From the results it is concluded that the obstacles do not have a constant activation energy as assumed by Seeger and theories of the temperature dependence should include this factor. It is shown that the dose dependence of lattice hardening may be described by the new formula

$$\sigma_i = A[1 - \exp(-B\phi)]^{1/2}$$

which is derived by combining the theoretically predicted dependence on $\phi^{1/2}$ with a saturation effect. The existence of obstacles of various sizes is also indicated from measurements of the temperature dependence of the constants in this equation. No definite conclusions as to the mechanism of formation of the obstacles can be made. The dislocation hardening component is shown to be independent of testing temperature in copper but not in nickel.

1005 EFFECTS OF IRRADIATION ON THE THERMAL CONDUCTIVITY OF SYNTHETIC SAPPHIRE.
R.Berman, E.L.Foster, B.Schneidmesser and S.M.A.Tirmizi.
J. appl. Phys. (USA), Vol. 31, No. 12, 2156-9 (Dec., 1960).

The thermal conductivity between 2° and 100°K was measured on synthetic sapphire single crystals and on sintered alumina, before and after reactor and γ-ray irradiations. Reactor irradiation appears to introduce two types of thermal resistivity-producing defect, one of which is dominant at low temperatures. The only effect of γ irradiation is an extra thermal resistivity at low temperatures which saturates for quite small doses. This saturation value seems to depend on the initial perfection of the crystal and is increased by reactor produced damage. At present, detailed information about the defects cannot be derived from thermal conductivity measurements alone.

1006 THE EJECTION OF ATOMS FROM GOLD CRYSTALS DURING PROTON IRRADIATION. M.W.Thompson.
Phil. Mag. (Eighth Ser.) (GB), Vol. 4, 139-41 (Jan., 1959).

Describes a method of determining the directions in which atoms leave the surface of a gold crystal under proton bombardment. The results suggest that the initial proton—atom collision is resolved into pulses along the close-packed atomic directions. R.Bullough

1007 EXAMINATION OF γ-IRRADIATED BENZENE FOR OPTICAL ACTIVITY. L.Spialter and J.H.Futrell.
Nature (GB), Vol. 188, 225-6 (Oct. 15, 1960).

Starodubtsev, Gurskiy and Sizykh (Abstr. 6416 of 1960) have reported a rotation of the plane of polarization in benzene after irradiation with γ-rays from a Co^{60} source with a flux of $3 \times 10^5\ r\ h^{-1}$. The rotation amounted to 0.7°-0.9° at a dosage of 10^7 r for a 10 cm path length. This paper describes an attempt to confirm this rotation. It was found that irradiation does bring about changes in colour, spectral absorption and smell but no rotation occurred. The polarimeter used was sensitive enough to detect 0.005° rotation. It is suggested that Starodubtsev et al. may have had either a contaminated sample or an imperfect polarimeter. H.G.Jerrard

ELECTRICAL PROPERTIES OF SOLIDS

(Superconductivity is included under Low-Temperature Physics)

1008 A MONTE-CARLO CALCULATION FOR A SIZE EFFECT PROBLEM. B.Lüthi and P.Wyder.
Helv. phys. Acta (Switzerland), Vol. 33, No. 6-7, 667-74 (1960).

The Monte-Carlo method is used for calculating a size effect problem in electrical conductivity in which, besides impurity and surface scattering, small angle electron—phonon scattering is also present. The calculated mean free path shows a dependence on the diameter of the wire in agreement with recent experimental results of Olsen (Abstr. 11055 of 1959). The method of calculation and the results are discussed in detail.

1009 THEORY OF MAGNETORESISTANCE. II. J.Hajdu.
Z. Phys. (Germany), Vol. 160, No. 5, 481-90 (1960). In German.

For Pt I, see Abstr. 17988 of 1960. The oscillatory behaviour of the magnetoresistance at low temperature is treated on the basis of a simple quantum theory of free electrons in a magnetic field, which takes into account only the discrete nature of the energy levels. An accurate treatment of the relaxation time and of the density matrix leads to the same results, which agree also with those obtained from a solution of the transport equation. L.Pincherle

MAGNETORESISTIVE MEASUREMENTS ON DOMAIN ROTATION IN Ni—Fe FILMS. See Abstr. 1223

1010 THE RESISTIVITY OF DILUTE MAGNETIC ALLOYS. A.J.Dekker.
Physica (Netherlands), Vol. 25, No. 12, 1244-52 (Dec., 1959).

The resistivity is discussed in terms of a model which assumes an exchange energy only between magnetic atoms which are nearest neighbours. The perturbing potential produced by the magnetic atoms is assumed to consist of a spin-independent and a spin-dependent part. It is shown that the elastic scattering resulting from nearest-neighbour pairs of magnetic atoms contains a temperature-dependent term. It is suggested that this model might explain the occurrence of a maximum followed by a minimum in the resistivity versus temperature curve observed for some alloys.

1011 FREQUENCY-DEPENDENT HALL EFFECT IN NORMAL AND SUPERCONDUCTING METALS. P.B.Miller.
Phys. Rev. (USA), Vol. 121, No. 2, 435-50 (Jan. 15, 1961).

The Hall current flow occurring in a normal and a superconducting metal when both a static magnetic field (H_0) and an electromagnetic wave are applied is calculated. The entire frequency range of the electromagnetic wave is discussed, although the emphasis is on the microwave range. The nonlocal, transverse Hall current in a normal metal is calculated by solving the Boltzmann equation. It is shown that the microwave Kerr rotation in a circular cylindrical cavity provides a good test for the nonlocal Hall current in a normal metal. The relation between a longitudinal and a transverse Hall current in a superconductor is briefly discussed. A detailed theory of the transverse Hall current in a superconductor based on the Bardeen—Cooper—Schrieffer model and including the effect of collective excitations is presented. The field H_0 is assumed constant in space and a general result for the Hall current in Q space is derived. When the electric field is constant in space ($Q \to 0$), it is shown that the Hall current is proportional to the microscopic analogue of the fraction of normal electrons of a two-fluid model.

1012 ON THE PHENOMENOLOGICAL THEORY OF ELECTRICAL CONDUCTIVITY OF FERRITES AND ANTIFERROMAGNETIC MATERIALS. E.A.Turov and Yu.P.Irkhin.
Fiz. Metallov i Metallovedenie (USSR), Vol. 9, No. 4, 488-97 (April, 1960). In Russian.

Theoretical. Based on the concept of a symmetrical and invariant model, an analysis is presented of those specific features of the energy spectrum of the current carriers in ferromagnetic and antiferromagnetic materials that are associated with their magnetic structure. The change of the energy spectrum of the current carriers which takes place on passing through the Curie point may lead to an "anomalous" temperature dependence of electrical conductivity. The theoretical form of these anomalies is compared with experimental results, and a new type of anomalous variation of electrical conductivity is predicted for ferrites in which the fields of exchange forces, exerted on spins of quasi-particles by the magnetic moments of different sublattices, compensate each other at a certain temperature. M.H.Sloboda

1013 GALVANOMAGNETIC TENSORS OF BISMUTH SINGLE CRYSTALS AT LOW TEMPERATURES.
S.Mase and S.Tanuma.
Sci. Rep. Res. Insts Tohoku Univ. A (Japan), Vol. 12, No. 1, 35-53 (Feb., 1960).

A measurement of the galvanomagnetic tensors of bismuth at the temperature of liquid helium and in magnetic fields up to 10 kOe is reported of three single crystals with different crystallographic orientations. All non-vanishing tensor components (except one) predicted by the crystal symmetry and Onsager's reciprocal relation were measured. The dependence of the symmetric tensor components on the direction of the magnetic field is studied in detail. The experimental results are analysed semi-phenomenologically on the basis of the Boltzmann equation. The experimental results of the absolute values and the field dependencies for the symmetric and antisymmetric tensor components respectively are such as expected theoretically in chemically pure samples. The anisotropy of the tensor components of typical type is, however, fairly small compared with that expected from the known energy surface anisotropy.

1014 ELECTRICAL PROPERTIES OF CRYSTAL COMPOUNDS OF GRAPHITE. I. CONDUCTANCE OF GRAPHITE/BROMINE.
L.C.F.Blackman, J.F.Mathews and A.R.Ubbelohde.
Proc. Roy. Soc A (GB), Vol. 256, 15-27 (May 31, 1960).

Measurements are reported of the electrical resistance of graphite-bromine of various compositions. Some of the experiments refer to natural graphite, but the majority deal with specimens of pyrolytic graphite which show good orientation with respect to both a- and c-axes. Changes of resistance in these two directions were measured as a function of bromine uptake to limiting concentrations; cyclic sorption—desorption studies were included where appropriate. Results are discussed in the light of current theories about the electron band structure in graphite and in relation to the nature of the bonding between bromine and graphite.

1015 ELECTRICAL PROPERTIES OF CRYSTAL COMPOUNDS OF GRAPHITE. II. ACID SALTS OF GRAPHITE.
L.C.F.Blackman, J.F.Mathews and A.R.Ubbelohde.
Proc. Roy. Soc. A(GB), Vol. 258, 329-38 (Oct. 25, 1960).

Experiments are described on the formation of crystal compounds of various compositions by anodic oxidation of well-oriented pyrolytic graphite Concentrated sulphuric acid was used in most cases; other acids were also examined Changes in the electrical resistance are discussed in relation to use of two-and three-dimensional electron energy band structure models See also following abstract.

1016 ELECTRICAL PROPERTIES OF CRYSTAL COMPOUNDS OF GRAPHITE. III. THE ROLE OF ELECTRON DONORS.

L.C.F.Blackman, J.F.Mathews and A.R.Ubbelohde.
Proc. Roy. Soc. (GB), A (GB), Vol. 258, 339-49 (Oct. 25, 1960).

Crystal compounds between potassium and well-oriented pyrolytic graphite were prepared with a range of compositions up to saturation. Measurements were made of changes of electrical resistance and of thermoelectric power as a function of composition in both a- and c-axis directions. Anisotropy of electrical resistance became smaller, and of thermoelectric power sank practically to zero, on compound formation. Compounds between graphite and rubidium or caesium were studied more briefly under conditions approximating to saturation. In the direction of the a-axis, the large decreases of electrical resistance observed could be interpreted on the basis that the alkali metal atoms inject electrons into the upper π-band of graphite. This was confirmed by the observed changes of thermoelectric power. Changes resembled but did not completely mirror those observed with electron acceptor compounds; the fractional transfer of electrons appeared to be less complete with the electron donors. In the direction of the c-axis, intercalation of the electron donor alkali metal atoms led to a much more striking decrease of electrical resistance than was observed with various electron acceptor groups. To supplement results previously published, brief studies are reported on crystal compounds between graphite and aluminium chloride, and graphite and iodine monochloride. Possible band models for graphite compounds with both electron donor and acceptor atoms are discussed in the light of the experimental findings. See also preceding abstract.

1017 ELECTRICAL CONDUCTION IN SOLIDS. III. THE CONTACT OF IRON SURFACES.

J.A.Greenwood and J.Harris.
Proc. Roy. Soc. A (GB), Vol. 257, 83-97 (Aug. 23, 1960).

Although the theoretical steady-state equilibrium relationship between potential and temperature in an electrically heated conductor was established since the beginning of the century (Kohlrausch, 1900) the important case in which equilibrium breaks down has until recently been overlooked. In Pt I (Abstr. 5003 of 1958) this was discussed experimentally with reference to gold contacts; in Pt II (Abstr. 5004 of 1958) it was shown theoretically that for suitable materials, equilibrium is only possible when the current is below a critical value. In the earlier experiments the metal contacts were free from contaminating films: this paper describes the behaviour of iron surfaces which are contaminated by an oxide layer. It is shown as before that conditions become unstable when the current is too large. Short pulse of current were passed through iron contacts. Currents below a critical size were found to have no effect; larger currents caused a growth of contact area and permanent decrease in contact resistance. When no contaminating films were present the product the of final contact resistance R_0 and the current I was constant. For iron contacts coated with varying amounts of oxide it was found that, instead of remaining constant, IR_0 increased steadily with the amount of contamination. The value observed for the cleanest contacts was close to the theoretical estimate for iron, while for badly contaminated ones it was two to three times as large. Experiments in which the length of the current pulse was varied demonstrate the dependence of the rate of heating on the contact area. Direct evidence for the unstable temperature rise is given by oscilloscope records of transient voltage across the contact during the passage of a current pulse. The observations are compared with a new theoretical estimate of the rate of temperature development in non-equilibrium conditions.

1018 ELECTRICAL RESISTIVITY OF COLD-WORKED AND HEAT-TREATED ALLOY Fe_3Al.

Ya.P.Selisskii.
Fiz. Metallov i Metallovedenie (USSR), Vol. 9, No. 4, 633-5 (April, 1960). In Russian.

A letter. Curves of electrical resistivity, ρ, versus degree of cold deformation, p, were constructed for Fe_3Al specimens (a) in the work-hardened condition, (b) annealed at 850°C and quenched, and (c) annealed at 850°C and cooled slowly to room temperature. In every case ρ reached a maximum at p = 34.5%, after which it decreased by 21% in (a), 26.1% in (b), and 19.1% in (c); the difference between ρ of the ordered and disordered alloys also depended on p. X-ray diffraction measurements of the specimens indicated that the effects observed were associated with the formation of texture at critical p.

M.H.Sloboda

1019 INVESTIGATION OF THE KINETIC CURVES OF ELECTRICAL RESISTIVITY OF ORDERED ALLOYS.

N.V.Volkenshtein and Yu.N.Tsiovkin.
Fiz. Metallov i Metallovedenie (USSR), Vol. 9, No. 4, 627-30 (April, 1960). In Russian.

Electrical resistivity versus time curves were constructed for the wire specimens of Ni–Mn (23.9 at % Mn) alloy in the ordered (cooled slowly to 460 or 380°C) and disordered (quenched from 1000-1200°C) condition. The resistance of rapidly heated specimens (rate of heating $\cong 10^3\,^\circ$C/sec) was measured by the pulse method which, it is claimed, makes it possible not only accurately to measure, but also to distinguish between the temperature of the order–disorder change and that of the ferromagnetic transformatio

M.H.Sloboda

1020 TEMPERATURE DEPENDENCE OF ELECTRICAL RESISTANCE OF PLASTICALLY DEFORMED SILVER AND COPPER.

V.I.Khotkevich, B.A.Pervakov and B.A.Merisov.
Fiz. Metallov i Metallovedenie (USSR), Vol. 9, No. 4, 637-9 (April, 1960). In Russian.

The temperature dependence of electrical resistance (R) of Ag and Cu, plastically deformed in compression at room temperature, was determined for the range 293-77°K, i.e. for temperatures at which changes of the structure-sensitive properties are not affected by the recovery or recrystallization processes. The increase in R, caused by plastic deformation, decreased with falling temperature, the changes in ΔR due to temperature variation being reversible. The effects observed were attributed to a change in the character of the thermal vibrations of atoms in the distorted regions of the crystal lattice.

M.H.Slobod

EFFECT OF AGEING IN ELECTRICAL RESISTIVITY OF 80 : 20 MANGANESE–COPPER ALLOY. See Abstr. 1297

1021 ON THE RELATION BETWEEN ZENER BREAKDOWN AND RESIDUAL RESISTANCE IN CRYSTALS.

P.Gosar.
Nuovo Cimento (Italy), Vol. 18, No. 2, 241-50 (Oct. 16, 1960).

The theory of the Zener breakdown of crystals is extended to the case of very strong electric fields. In the domain of breakdown the resistivity of the crystal decreases very rapidly with the increase of the electric field until it reaches a finite value, which depends no more on the electric field. This resistivity is due to the scattering of electrons by the periodic potential of the lattice. It is shown that the limit value of resistivity can be calculated similarly as the residual resistance due to impurities. The interpretation of residual resistance as the Zener breakdown of a crystal with many narrow energy gaps is given. The gaps in the conduction band of the ideal crystal are produced by the presence of impurity centres. A theory of the electron transport in the crystal with many energy gaps is formulated. The comparison with the Boltzmann–Bloch transport theory is given.

1022 FIELD-DEPENDENT ELECTRON MOBILITY IN IONIC CRYSTALS.

J.F.Barnes and R.H.Tredgold.
Proc. Phys. Soc. (GB), Vol. 76, Pt 2, 261-6 (Aug., 1960).

The Boltzmann equation for electronic conduction in an ionic crystal is set up and an approximate solution is obtained through terms in the cube of the field. Explicit results are obtained for values of $\hbar\omega_0$ of 2kT and $\frac{1}{2}$kT, where ω_0 is the angular frequency of longitudinal optical modes. It is shown that for fields less than the known breakdown fields the mobility decreases with increasing field. The non-ohmic effects will always be negligible for fields less than 10^5 V/cm.

1023 SPACE-CHARGE-LIMITED CURRENTS IN RESIN FILMS.

R.E.McCurry and R.M.Schaffert.
IBM J Res. Developm. (USA), Vol. 4, No. 3, 359-63 (July, 1960).

Measurements of the mobility of charges through thin resin films are reported. The films were charged by a corona discharg to a potential between 100 and 800 V and the decay of potential with time was measured by an electrometer. In most cases the reciprocal of the potential was a linear function of time, which is shown to imply a square-law dependence of current upon voltage and to allow the mobility to be calculated by a formula due to Rose (Abst 4645 of 1955). The mobility depended strongly upon relative humidity and, for this reason, ions rather than electrons are proposed as the charge carriers.

R.G.C.Arridg

1024 EFFECT OF HIGH PRESSURE ON ELECTRICAL PROPERTIES OF NiO, CoO, CuO, AND Cu_2O.

.P.Young, W.B.Wilson and C.M.Schwartz.
hys. Rev. (USA), Vol. 121, No. 1, 77-82 (Jan. 1, 1961).

The effect of pressure on electrical resistance and Seebeck co-
fficient at or near room temperature in NiO, CoO, CuO, and Cu_2O
as determined. Equations relating the Seebeck coefficient to hole
oncentration were used to calculate the effect of pressure on hole
obility. In all materials examined, hole mobility was decreased
y pressures to 60 000 atm. It has been proposed that NiO charge
ansport occurs by the motion of holes trapped at local sites by
olarization of the surrounding lattice. The effect of pressure on
e diffusion of self-trapped holes was considered. Motion of self-
apped holes in an ionic crystal and of vacancies in a metal may be
imilar to the extent that the motion of either probably involves
ooperative movements of surrounding ions or atoms. Some inward
elaxation probably occurs around either a hole trapped at a local
ite in an ionic crystal or around a vacancy in a metal. In either
ase pressure would be expected to decrease the jump frequency for
otion of the defect. It is proposed that in NiO, CoO, and CuO, the
ecreased hole mobility with pressure was due to a decrease in
iffusion rate of self-trapped holes. The explanation for pressure
ffects in Cu_2O may be more complicated since Cu_2O is generally
egarded as a wide-band semiconductor.

1025 IONIC HALL EFFECT IN SODIUM CHLORIDE.

P.L.Read and E.Katz.
hys. Rev. Letters (USA), Vol. 5, No. 10, 466-8 (Nov. 15, 1960).

Hall measurements were made at seven temperatures between
10° and $780^{\circ}C$. The observed over-all Hall mobilities were of the
rder 10^{-7}– 10^{-8} $m^2 V^{-1} sec^{-1}$. The data were not accurate enough
o permit resolution of the mobilities of the Na and Cl ions. How-
ver a rough estimate could be made of the mobility of the Na ions,
hich was found to have an activation energy of 0.87 ± 0.10 eV, in
greement with previous determinations by other methods. The
bserved Hall mobilities are approximately equal to the drift mobi-
ities measured by other workers. L.Pincherle

1026 EFFECTS OF γ-RAY AND NEUTRON IRRADIATION ON THE PYROLITIC CARBON FILM RESISTORS.

.Nakai and T.Sakakibara.
ci. Pap. Inst. Phys. Chem. Res. (Japan), Vol. 54, No. 1, 88-96
March, 1960).

Various kinds of pyrolitic carbon film resistors were irradiated
d the change of their electric properties was measured. The
esistance of all the samples increased with increase of radiation
ose. The change of the temperature coefficient of resistance was
easured and the effects of the ambient gases were investigated.
he current noise characteristics were studied and results con-
stent with other experiments obtained. The important role of the
nbient gases is emphasized.

emiconductors

1027 PHYSICS OF SEMICONDUCTORS.

R.A.Smith.
ature (GB), Vol. 188, 632-3 (Nov. 19, 1960).

Report of an international conference sponsored by the Inter-
ational Union of Pure and Applied Physics and arranged by the Czecho-
lovak Academy of Sciences which was held in Prague on 29 Aug.-
Sept. 1960. Over 265 papers were selected for inclusion of which
pproximately half were read. Nearly 750 physicists attended and
s a result it was necessary to divide the conference into four
arallel streams. As was to be expected the papers ranged over an
xtremely wide field.

1028 PROCEEDINGS OF THE SECOND CONFERENCE ON SEMICONDUCTOR SURFACES.

Phys. Chem. Solids (GB), Vol. 14 (July, 1960).

The conference took place at the U.S. Naval Ordinance Labora-
ry, Silver Spring, Maryland,in Dec. 1959. Six sessions were held
der the following headings (1) Cleaned surfaces of germanium and
licon, (2) New techniques, (3) Chemistry, (4) Compound semi-
nductor surfaces, (5) Ordinary surfaces of germanium and silicon
) Theory. Abstracts of papers presented will be found in this or
cceeding issues of Physics Abstracts.

1029 ON THE ELECTRICAL CONDUCTIVITY OF POLAR SEMICONDUCTORS AT HIGH FREQUENCIES.

P.H.Fang.
Ann. Phys. (Germany), Vol. 6, No. 3-4, 115-19 (1960).

Stolz's expression (Abstr. 9172 of 1957, 7008 of 1959) for the complex electrical conductivity of polar semiconductors as a function of the applied frequency is numerically evaluated. The conductivity is represented in the usual form of the frequency spectrum, as well as in the form of an Argand diagram. The latter representation shows that this dispersion function of the complex conductivity of polar semiconductors is almost identical to the dispersion function of the dielectric permitivity given by Cole and Cole (1941). From the approximate symmetry of the dispersion function in logarithmic relaxation time spece, it is concluded that the relaxation time can be determined with reasonable accuracy from the peak of the imaginary part of the complex conductivity, or from the inflection point of the real part.

1030 DEFORMATION POTENTIAL THEORY OF SEMICONDUCTORS WITH COMPLEX BAND STRUCTURE.

G.L.Bir and G.E.Pikus.
Fiz. tverdogo Tela (USSR), Vol. 2, No. 9, 2287-2300 (Sept., 1960).
In Russian.

Deformation potential theory is developed for semiconductors with complex energy-band structure. An operator is derived for the interaction of electrons with long-wavelength acoustic and optical phonons, and the transition probabilities are calculated. General expressions are obtained and used to find matrix elements for the scattering of holes in p-type germanium. [English translation in: Soviet Physics—Solid State (USA)]. A.Tybulewicz

1031 THE TRUE LIFETIME AND POSSIBLE MECHANISM OF INELASTIC SCATTERING OF CURRENT CARRIERS IN SEMICONDUCTORS.

S.M.Rȳvkin.
Fiz. tverdogo Tela (USSR), Vol. 2, No. 10, 2411-20 (Oct., 1960).
In Russian.

The lifetime of nonequilibrium carriers in allowed bands, e.g. electrons in the conduction band, is $\tau_{\Delta n} = \Delta n_{st}/U$, where Δn_{st} is the stationary concentrations of nonequilibrium electrons and U is the intensity of the generation process. The "true" lifetime for all the carriers in the band is

$$\tau_{tr} = 1/\sum_{k} v_{nk} q_{nk} p_k,$$

where p_k is the concentration of holes of the k-th kind, q_{nk} the capture cross-section of these holes for electrons and v_{nk} is the relative velocity of electrons and the k-holes. The relation between the two lifetimes is derived for impurity photoconductivity, and for intrinsic photoconductivity with recombination by deep traps and by deep traps in the presence of shallow trapping levels. [English translation in: Soviet Physics—Solid State (USA)]. R.Berman

1032 THE APPLICABILITY OF THE STATIONARY PHOTOCONDUCTIVITY METHOD FOR STUDYING THE DEPENDENCE OF THE RATE OF SURFACE RECOMBINATION ON THE SURFACE POTENTIAL.

A.V.Rzhanov.
Fiz. tverdogo Tela (USSR), Vol. 2, No. 10, 2431-8 (Oct., 1960).
In Russian.

The stationary photoconductivity (the duration of the light pulse is much longer than the effective lifetime) and effective field are measured simultaneously for large signals. The method can be used over the whole range of obtainable fields. It is shown that the change in surface conductivity with illumination can be neglected and the method is applicable for practically any level of injection. The basis of the method is discussed; it is very rapid and changes in surface recombination centres can be followed. [English translation in: Soviet Physics—Solid State (USA)]. R.Berman

1033 TRAPPING AND RECOMBINATION AT MANY-ELECTRON CAPTURE CENTRES IN SEMICONDUCTORS.

S.G.Kalashnikov and K.P.Tissen.
Fiz. tverdogo Tela (USSR), Vol. 2, No. 11, 2743-52 (Nov., 1960).
In Russian.

Equations are given for the kinetics of capture and recombination of electrons and holes at many-electron centres in a non-degenerate semiconductor. Expressions are deduced for carrier lifetime under steady-state conditions for any concentration of capture centres with two energy levels. Conditions are discussed for appearance of trapping and the effect of trapping on the measured lifetimes. [English translation in: Soviet Physics—Solid State (USA)]. A.Tybulewicz

1034 SEMICONDUCTOR SURFACE PROPERTIES DEDUCED FROM FREE CARRIER ABSORPTION AND REFLECTION OF INFRARED RADIATION. N.J.Harrick.
J. Phys. Chem. Solids (GB), Vol. 14, 60-71 (July, 1960).

The use of infrared radiation to study semiconductor bulk properties through the absorption by the free carriers is reviewed. Numerous applications of this technique and variations thereof are then discussed whereby properties of semiconductor surfaces may be determined. It is shown that in many instances the techniques described here have distinct advantages over other techniques presently in use.

1035 INFLUENCE OF TRAPPING, DIFFUSION AND RECOMBINATION ON CARRIER CONCENTRATION FLUCTUATIONS. M.Lax and P.Mengert.
J. Phys. Chem. Solids (GB), Vol. 14, 248-67 (July, 1960).

Carrier concentration fluctuations are found to be relatively large in regions of low concentration. Diffusion is shown to add a $(1/\omega)^{3/2}$ boundary term (important at high frequencies) to the usual volume recombination spectrum This result is found to be valid independent of the geometry or the number of dimensions. But for the case of surface recombination it is multiplied by a frequency dependent probability that an electron having left the region will not return. Traps of large cross-section are characterized by a fast trapping rate and an exceedingly slow effective recombination rate caused by multiple trapping. The fast rate is unaffected by diffusion. The slow rate shown by a method of low mode isolation to be approximately describable in terms of an effective diffusion constant reduced in about the same ratio as the recombination. The resulting $(1/\omega)^{3/2}$ spectrum is thus shifted to a low frequency region and increased enormously in strength.

1036 VOLUME-CONTROLLED, TWO-CARRIER CURRENTS IN SOLIDS: THE INJECTED PLASMA CASE.
M.A.Lampert and A.Rose.
Phys. Rev. (USA), Vol. 121, No. 1, 26-37 (Jan. 1, 1961).

Double injection into semiconductors and insulators is studied under conditions where the injected electrons and holes are free (injected plasma), the current is colume-controlled, i.e. determined by distributed space charge, and the current is field-driven (diffusion negligible). The major results are, assuming a one-dimensional geometry and carrier lifetime independent of injection level, for extrinsic semiconductors, (i) an extended voltage region over which $J \propto V^2$ (J current density and V voltage), and (ii) depression of the current, at fixed voltage, in the square-law region through increase in the number of thermal minority carriers, $J \propto |n_T - p_T|$, with n_T, p_T the thermal-equilibrium densities of electrons and holes, respectively. This unusual behaviour is shown to be a direct consequence of recombination kinetic requirements. For insulators, assuming trapping is negligible, $J \propto V^3$. A rigorous solution is obtained for the constant-lifetime problem, valid for both semiconductors and trap-free insulators. This solution furnishes a good approximation also for variable-lifetime cases, e.g. bimolecular recombination kinetics. See also following abstract.

1037 CURRENT—VOLTAGE CHARACTERISTICS OF FORWARD BIASED LONG p-i-n STRUCTURES.
R.D.Larrabee.
Phys. Rev. (USA), Vol. 121, No. 1, 37-9 (Jan. 1, 1961).

Current—voltage characteristics were observed in several germanium p-i-n structures in which the n side was biased negative and the p side positive so as to cause a double injection of electrons and holes into the structure. The middle i section was constructed of good quality germanium (approximately 2×10^{13} donors/cm^3) and was many minority carrier diffusion lengths long. The observed I—V characteristics display a low-field region in which the current is proportional to the voltage followed by a higher field region in which the current is proportional to the square of the voltage. In the square-law region, the current is a function of the difference, rather than the sum, of the thermal densities of the electrons and holes. These observations lend experimental support to the basic theories of Lampert and Rose (preceding abstract) regarding volume-controlled double injection into a semiconductor.

1038 ONE-DIMENSIONAL OVERLAP FUNCTIONS AND THEIR APPLICATION TO AUGER RECOMBINATION IN SEMICONDUCTORS. A.R.Beattie and P.T.Landsberg.
Proc. Roy. Soc A (GB), Vol. 258, 486-95 (Nov. 8, 1960).

The theoretical lifetime of excess carriers in semiconductors limited only by the Auger recombination mechanism previously discussed by the present authors, depends on a temperature-independent parameter. This involves certain overlap integrals. They are of the form $\int u^*(k_1, r)\, u(k_2, r)\, dr$, where the u's are the modulating parts of Bloch wave-functions. The integrals are calculated in this paper on the basis of a Kronig—Penney model. The value of the parameter obtained is shown to be rather insensitive to many details of the model used. When the value found is inserted into the previously published theory of lifetimes in InSb, very good agreement is obtained with the more detailed experimental results which have recently become available. This strongly suggests that the dominant recombination mechanism in InSb at elevated temperatures has been identified. A more general analysis of the properties of the overlap integrals is also given in this paper.

1039 ELECTRICAL CONDUCTIVITY OF THIN FILMS OF SEMICONDUCTORS. G.Chobanu and N.Kroitoru.
Rev. de Physique (Roumania), Vol. 5, No. 2, 181-8 (1960).
In Russian.

The conductivity is calculated for a film thickness comparable with the thickness of the space-charge layer or with the carrier mean free path. The variation of σ with field (E) depends on $\beta = (eEl_0/kT)$, where E is the field at the surface, l_0 the mean free path. For $\beta \ll 1$, σ varies linearly with field. For $\beta \gg 1$, $\sigma \propto 1/E$. At room temperature, for a film of 10^{-4} cm, a field of 10^4 V/cm should be sufficient to achieve the latter condition. R.Berman

APPLICATION OF MAGNETIC RESONANCE TECHNIQUES TO THE STUDY OF SEMICONDUCTOR SURFACES. See Abstr. 1257

Semiconducting Materials

1040 SEMICONDUCTING COMPOUNDS.
E.Mooser.
Science (USA), Vol. 132, 1285-91 (Nov. 4, 1960).

Survey article on the influence of chemical composition and crystal structure on semiconducting properties. 25 references.

1041 VARIATION AS A FUNCTION OF PRESSURE OF THE LIFETIME OF THE FREE MINORITY CARRIERS IN GERMANIUM. A.Sorlin.
Bull. Acad. Polon. Sci. Ser. Sci. math. astron. phys. (Poland), Vol. 8, No. 1, 71-5 (1960). In French.

The lifetime of the free minority carriers in germanium was observed to decrease with increase in pressure. The variation can be explained on the Shockley—Read theory by assuming that the activation energy of the recombination centres is proportional to the width of the forbidden energy gap. J.B Birks

1042 ON THE RELATION BETWEEN ANOMALOUS RESISTIVITY AND CONCENTRATION GRADIENT OF CARRIERS IN GERMANIUM. Z.Majewski, S.Sikorski and J.Świderski.
Bull. Acad. Polon. Sci. Ser. Sci. tech. (Poland), Vol. 7, No. 6, 401-6 (1959).

When the two-probe method is used to check the variation of resistivity along germanium specimens of high purity, values anomalously high (~80 ohm cm) may be observed in some regions. The latter seem to be associated with concentration gradients and occur where large photovoltages are observed The photovoltages are larger than the values for the volume effect estimated from the theory of Tauc (1955). C.A.Hogarth

1043 A STUDY OF THE SEMICONDUCTING PROPERTIES O SELENIDES AND TELLURIDES OF GERMANIUM AND TIN. J.W.Verstrepen.
C.R. Acad. Sci. (France), Vol. 251, No. 13, 1273-4 (Sept. 26, 1960). In French.

Compounds were prepared from spectroscopically pure components. The tellurides were highly degenerate with $p \sim 10^{-4}$ ohm cm and a thermoelectric power of $\sim 50\mu$V/deg C for temperatures between 140° and 800°K. The selenides show typical semiconducting properties. The resistivity varies from 10^3 ohm cm at low temperatures to 10^{-4} ohm cm at high temperatures. The thermoelectric power is $\sim 600\,\mu$V/deg C at room temperature but decreases rapidly with increase in temperature. The properties of mixtures of selenides and tellurides were examined. D.J.Olive

1044

ANISOTROPY OF THE GALVANO- AND THERMO-MAGNETIC PHENOMENA IN N-TYPE GERMANIUM.

.M.Tsidil'kovskii and V.P.Shirokovskii.
Fiz. Metallov i Metallovedenie (USSR), Vol. 9, No. 3, 321-6 (March, 1960). In Russian.

Theoretical. To elucidate the effect of anisotropy of the energy spectrum of the current carriers on the properties of n-type Ge, the galvano- and thermo-magnetic properties were analytically determined with the aid of a model in which the energy surface is characerized by 4 extrema, situated on the principal diagonals of the cubic attice. The effect of drag, exerted on electrons by phonons, was neglected in the calculations, and it was assumed that the kinetic effects depend solely on the transitions between states related to one extremum only and that the processes, associated with collisions, are described by relaxation time which is isotropic and which depends on the electron energy only. M.H.Sloboda

1045

INVESTIGATION OF THE ENERGY DISTRIBUTION OF SURFACE ELECTRON STATES IN CLEANED GERMANIUM SURFACE AND WITH ADSORPTION OF OXYGEN.

V.I.Lyashenko, N.S.Chernaya and A.B.Gerasimov.
Fiz. tverdogo Tela (USSR), Vol. 2, No. 10, 2421-30 (Oct., 1960). In Russian.

Atomically clean surfaces of Ge were obtained by Farnsworth's method and the field effect used to find the parameters of the surface levels. The clean surface showed states of large density, probably connected with the discontinuity of the crystal lattice. It was established that levels with parameters $E = -2.5$ kT (relative to the middle of the forbidden band) and $N \sim 10^{11}$ cm^{-2} were connected with oxygen which saturates the free covalent bonds of the Ge surface atoms. [English translation in: Soviet Physics—Solid State (USA)]. D.J.Huntley

1046

CONCENTRATION EFFECT IN GERMANIUM.

V.R.Karasik and G.B.Kurganov.
Fiz. tverdogo Tela (USSR), Vol. 2, No. 10, 2594-5 (Oct., 1960). In Russian.

The Hall constant (R) and magnetoresistance (ρ_H) of p-type Ge were measured in pulsed magnetic fields up to 250 kOe at 20°K. R was field independent up to 90 kOe, but thereafter increased linearly with field. ρ_H varied linearly with field up to 90 kOe, but thereafter rose more rapidly. No effect on R was observed at 77°K. D.J.Huntley

1047

ELECTRICAL PROPERTIES OF CLEAVED GERMANIUM SURFACES.

D.R.Palmer, S.R.Morrison and C.E.Dauenbaugh.
J. Phys. Chem. Solids (GB), Vol. 14, 27-32 (July, 1960).

The effects of oxygen on the electrical properties of a cleaved germanium surface have been studied by measuring the field effect, conductance, and photoconductance. . Upon cleavage, the surface is more p-type than the bulk and remains unchanged in a vacuum of about 10^{-9} mm Hg or less. When initially exposed to oxygen, the conductance tends towards a more p-type surface; then the surface changes towards n-type continuously at a constant oxygen pressure. When the system is evacuated, the surface reversibly becomes more p-type, indicating that oxygen tends to make the surface more n-type. In addition, the slow relaxation of the field effect in oxygen almost disappears in vacuum. The surface eventually becomes n-type in oxygen at 15 mm Hg for all of the samples measured, an effect which has not apparently been observed on surfaces cleaned by argon bombardment. The results are interpreted in terms of acceptor states at the surface and donor states which depend on sorbed oxygen and produce a slow relaxation of the field effect.

1048

IMPURITY CONDUCTION OF CLEANED GERMANIUM SURFACES AT LOW TEMPERATURES.

A.Kobayashi, Z.Oda, S.Kawaji, H.Arata and K.Sugiyama.
J. Phys. Chem. Solids (GB), Vol. 14, 37-42 (July, 1960).

The conductivity and Hall effect of cleaned germanium surfaces have been measured in the temperature range between 1.7°K and 300°K. The surface was cleaned by Joule heating at ~800-850°C in ultra-high vacuum for ~20-30 hr and was then annealed at 650°C for several hours. Results obtained with ~20-40 ohm cm p-type samples show that the Hall coefficient has a steep maximum at ~10-20°K and the resistivity becomes almost flat below this temperature range. This character is similar to that of bulk impurity conduction found by Hung et al., but disappears on exposure to air which causes marked increases in both the Hall coefficient and resistivity at low temperatures. This impurity conduction is attributed to the surface imperfections introduced by the cleaning treatment of the surface. The mobility and concentration of carriers in this surface conduction are estimated.

1049

OBSERVATIONS OF SURFACE TRANSVERSE MAGNETO-RESISTANCE EFFECTS ON N-TYPE GERMANIUM.

W.A.Albers, Jr and J.E.Thomas, Jr.
J. Phys. Chem. Solids (GB), Vol. 14, 181-5 (July, 1960).

New techniques of preparing thin semiconductor samples of uniform thickness have been developed, which allow for high sensitivity in the measurement of surface effects. Measurements of the surface transverse magnetoresistance effects first reported by Zemel and Petritz have been extended to lower resistivity n-type material of crystallographic orientation. Data were obtained for directions of the magnetic field both in and perpendicular to the plane of the thin films. Large swings in surface potential were accomplished by employing an HF rinse prior to ambient cycling. Observations of surface transverse magnetoresistance effects as a function of surface potential at fixed magnetic field strengths, and as a function of magnetic field strength at fixed surface potentials are reported. The analysis of the data requires a general solution of Poisson's equation which does not employ the semi-infinite geometry in order to ascertain values of the electric field at the surface of a semiconductor. This general solution is presented for several cases of sample thickness and resistivity and the deviations from the semi-infinite geometry solutions are delineated. Finally, the observations of the surface transverse magnetoresistance effect are discussed in view of the present theoretical model of the surface.

1050

SURFACE MOBILITY MEASUREMENTS IN GERMANIUM.

A.Many, N.B.Grover, Y.Goldstein and E.Harnik.
J. Phys. Chem. Solids (GB), Vol. 14, 186-92 (July, 1960).

Measurements are reported of the surface mobility in accumulation layers of germanium at low temperatures, and results obtained are compared with the theoretical calculations of Schrieffer. Advantage is taken here of the relatively slow thermal release of charge from many of the surface states into the majority-carrier band at sufficiently low temperatures. By the use of the pulsed field-effect technique, a rapid decrease in majority-carrier concentration within the space-charge region is effected. The change in surface conductance measured at the onset of the pulse, before the deficit induced can be redistributed between the states and the majority-carrier band, then becomes a direct measure of the majority-carrier surface mobility. The results for n-type samples show that Schrieffer's corrections for electrons are overestimated. On the assumption that the theoretical values are valid for accumulation layers, it is concluded that the surface is not a completely diffuse scatterer.

1051

FAST SURFACE STATES IN GERMANIUM AT LOW TEMPERATURES.

E.Harnik, Y.Goldstein, N.B.Grover and A.Many.
J. Phys. Chem. Solids (GB), Vol. 14, 193-9 (July, 1960).

The characteristics of fast states on real germanium surfaces have been investigated at low temperatures. Measurements of the time-constant of relaxation processes involving the interaction between the fast states and the majority-carrier band were carried out on n-type samples as a function of temperature and surface potential using a pulsed field-effect technique. These were complemented with measurements of trapped charge density as a function of barrier height at various low temperatures. It is shown that the experimental results at such temperatures can be reconciled with room temperature data only by the assumption that both the energy of the recombination centre, with respect to the conduction-band edge, and its capture cross-section for electrons are temperature dependent. The recombination level is found to move closer to the conduction band as the temperature is reduced while its capture cross-section for electrons decreases as $\exp(-E_r/kT)$, where the activation energy E_r is about 0.2 eV. There are also indications of surface traps within 0.06 eV from the conduction band which have very small capture cross-sections for electrons. It has been observed that for values of the surface potential corresponding to strong depletion layers the relaxation phenomena are dominated by a process of enhanced generation of minority carriers, the mechanism of which is not understood.

1052

SURFACE RELAXATION EFFECTS IN GERMANIUM AT REDUCED TEMPERATURES.

D.H.Lindley and P.C.Banbury.
J. Phys. Chem. Solids (GB), Vol. 14, 200-7 (July, 1960).

Measurements of small signal field effect mobility on germanium as a function of frequency of the applied a.c. field and under-pulsed fields have been extended in temperature down to 100° K. The measurements have been made for various values of a superimposed d.c. field giving a range of barrier heights as deduced from the d.c. conductance. Relaxation processes have been observed with characteristic times in the range $1\text{-}10^{-6}$ sec, depending on the temperature and the barrier height. In inversion layers the relaxation can be represented by a single time constant, whilst in other types of barrier the relaxations are not exponential. The effects are sensitive to illumination. The results are discussed in terms of surface trapping and recombination, and a comparison is made with predictions from Garrett's analysis.

1053 THE EVALUATION OF GERMANIUM SURFACE TREATMENTS.

S.R.Morrison.

J. Phys. Chem. Solids (GB), Vol. 14, 214-19 (July, 1960).

Studies have been made of the variations of electrical surface properties with surface treatment. The variables measured are the field effect mobility and the surface recombination velocity. A report is presented of the results with various etch systems, the influence of contamination in the etch or rinse water (some contaminants are found seriously to alter the characteristics with as low as 0.5 p.p.m.) and the variation of surface properties during heat treatment. A method has been developed for rapid estimation of surface barrier, density of fast states and reproducibility of the surface (with the large number of variables associated with surface treatments, rapidity in accumulation and interpretation of data is essential). These parameters (surface barrier, etc.) are obtained from the measurements discussed above and a set of calibration curves developed for the purpose. The method requires the energy levels of the fast states to be independent of surface treatment (or another set of calibration curves be developed for the new set of energies) but is self-checking with respect to this energy level parameter. Of those treatments used to date, the only one which has not been comparable in energy levels produced is the electrolytically etched surface, and a more exact analysis by Wallis and Wang has indicated also that here the energy levels are at considerably different values. The experimental results are interpreted in terms of fast state density and surface barrier using this method. Evidence will be presented that under certain treatments water vapour can change the density of recombination centres.

1054 ON RECOMBINATION NOISE IN GERMANIUM IN THE RANGE OF IMPURITY SEMICONDUCTION.

G.Lautz and M.Pilkuhn.

Naturwissenschaften (Germany), Vol. 47, No. 17, 394 (1960). In German.

Single crystals of n- and p-type Ge were studied from 5° K up to room temperature. From the frequency analysis of the noise spectrum a 1/f recombination noise component can be observed.

C.A.Hogarth

1055 RECOMBINATION OF ELECTRONS AND DONORS IN n-TYPE GERMANIUM.

G.Ascarelli and S.C.Brown.

Phys. Rev. (USA), Vol. 120, No. 5, 1615-26 (Dec. 1, 1960).

Describes a study of the recombination of electrons donors at helium temperatures. The excess electron density is obtained by means of low-temperature breakdown. Experimental results indicate that the recombination probability varies approximately with the inverse of the square of the temperature. Recombination light was detected. The origin of the disagreement of the present measurements with those published by Koenig is discussed, and evidence is given to explain the discrepancies between the two measurements. The magnitude of the recombination cross-section appears to depend on the binding energy of the electrons to the donor impurities, but large errors that are present in the determination of N_A are responsible for a large uncertainty in the absolute magnitude of the cross-section. The cross-sections vary from 10^{-12} to 10^{-11} cm^2.

1056 A REVERSED CARRIER TRANSPORT EFFECT IN GERMANIUM.

A.C.Prior.

Proc. Phys. Soc. (GB), Vol. 76, Pt 4, 465-80 (Oct. 1, 1960).

The difference in the behaviour of electrons and holes in germanium in the degree of departure from linearity of their drift velocity—electric field relationships is shown theoretically and experimentally to influence substantially the motion of a density distribution in near intrinsic material at high fields. In n-type germanium the normal motion can be reversed. A consequence is that injection or extraction, depending on the nature of the contact, can occur from the negative end of an n-type specimen. Cross-section variations can also act as sources of injection or extraction. An apparent negative resistance was observed, and a tentative explanation is given. Changes in mobility ratio due to mechanical stress can have an appreciable effect at high field, and it is shown that even at low fields interpretation of piezoresistance measuremen could be influenced by these considerations.

1057 INFRARED INVESTIGATION OF THE ACCEPTOR LEVELS FORMED BY COPPER IN GERMANIUM.

D.L.Greenaway.

Proc. Phys. Soc. (GB), Vol. 76, Pt 6, 900-8 (Dec. 1, 1960).

Infrared absorption measurements from 1 to 34 μ were made on germanium containing varying amounts of antimony and copper at temperatures down to 20° K. The results indicated that the three acceptor levels introduced by copper into germanium could be identified by their effect on the low-temperature absorption spectra of suitably doped samples. The appearance of the levels was in good agreement with the existing theory, and in addition to this, an excited state of the shallow acceptor level was identified which has not been previously reported.

1058 INTERACTION OF HIGH-ENERGY PHONONS IN GERMANIUM.

G.Ascarelli.

Phys. Rev. Letters (USA), Vol. 5, No. 8, 367-9 (Oct. 15, 1960).

An experiment is described in which energy transport is observed due to phonons emitted by electrons accelerated by an applied electric field. The specimen used was very pure n-type Sb-doped Ge. The observed amount of energy transport depended upon whether or not the drift velocity of the electrons was directed towards the region of the specimen in which temperature changes could be detected. From the observed behaviour, estimates are made of the average phonon energy and mean free path.

K.G.Major

1059 THEORY OF HOT-ELECTRON EFFECTS IN MANY-VALLEY SEMICONDUCTORS IN THE REGION OF HIGH ELECTRIC FIELD.

H.G.Reik, H.Risken and G.Finger.

Phys. Rev. Letters (USA), Vol. 5, No. 9, 423-5 (Nov. 1, 1960).

Calculations for n-type germanium, using deformation potential theory, were made subject to a number of simplifying assumptions (neglect of intervalley scattering and electron—electron collisions etc.). Results are given which include expressions for electron temperature, drift velocity and optical deformation potential constants.

P.T.Landsberg

1060 INCORPORATION OF Au INTO VAPOR-GROWN Ge.

W.E.Baker and D.M.J.Compton.

IBM J. Res. Developm. (USA), Vol. 4, No. 3, 296-8 (July, 1960).

Gold was incorporated into germanium grown in a closed tube by the iodide vapour growth process. Typical concentrations obtained were 3×10^{17} Au atoms cm^{-3} which is higher than the 5×10^{15} atoms cm^{-3} obtained by growth from the melt at 920° C. Only about 1 in 40 Au atoms appear to be in substitutional positions, since low-field Hall effect and resistivity measurements as a function of temperature showed that the samples contained about 7×10^{15} acceptors cm^{-3}. The gold atoms which do not act as acceptors could be incorporated in non-substitutional positions or as an iodide within the germanium lattice. It has not been possible to introduce gold by the open tube method which suggests that the high Au vapour pressure obtainable with the closed tube is instrumental in the process. The authors estimate the ratio of Au in the vapour to gold in the solid at 10^{-6} for electrically active gold atoms.

I.Cooke

1061 TEMPERATURE DEPENDENCE OF CARRIER DENSITIES, MOBILITIES, DIFFUSION CONSTANTS AND CONDUCTIVITIES IN GERMANIUM AND SILICON.

W.W.Gartner.

Semiconductor Prod. (USA), Vol. 3, No. 7, 29-31 (July, 1960).

The various parameters have been computed from recognized formulae and constants in the recent literature and are presented graphically for the temperature range of −50 to +250° C and impurit concentration range of 10^{13} to 10^{19} cm^{-3}. Only one kind of impurity centre is assumed for each material (i.e. the effects of partial compensation are not considered).

F.F.Roberts

1062 ENERGY LEVEL DIAGRAMS FOR GERMANIUM AND SILICON SURFACES.

P.Handler.

J. Phys. Chem. Solids (GB), Vol. 14, 1-8 (July, 1960).

The concept of localized atomic orbitals has been used to show how the structure and type of binding of surface atoms to the crysta may affect the energy level diagram of the surface region. In particular it has been shown in a qualitative way that the s or p character of the nonbonding orbitals of the surface atoms may dermine the energy of the surface state bands and the type of space narge region at cleaned germanium and silicon surfaces. The ansport data of the p-type space charge region of the cleaned ermanium have been used to determine the parameters, N_0, the ensity of states per cm^{2}eV, and $(E_F - E_0)$, the degree of degeneracy a two-dimensional surface state band. Using the value of these arameters obtained from the transport data and the simple model a two-dimensional state band, it has been shown that the linear emperature dependence of the thermionic emission data of Allen silicon may be predicted to within a factor of 2 or 3.

STUDIES OF AUGER ELECTRONS EJECTED FROM ERMANIUM BY SLOWLY MOVING POSITIVE IONS. See bstr. 320

1063 MICROWAVE FARADAY EFFECT IN SILICON AND GERMANIUM. J.K.Furdyna and S.Broersma.

hys. Rev. (USA), Vol. 120, No. 6, 1995-2003 (Dec. 15, 1960).

The Faraday rotation and ellipticity in a system of quasifree arriers is discussed and applied to microwave measurements on emiconductors. The theoretical expressions for these effects are nalysed with a digital computer for various ranges of the magnetic eld B, the mobility μ, the conductivity σ, the frequency ω, the ollision time τ and the dielectric constant of the host material. It possible to simplify these expressions in certain limiting cases. or μB smaller than unity, the rotation and ellipticity are pro- ortional to B. For μB larger than both unity and $\omega\tau$, they decrease s B^{-1} and B^{-3}, respectively. A maximum occurs near $\mu B = 1$ when τ is small. Rotation measurements on n- and p-type single crystals silicon at room temperature, with resistivities from 0.5 to) ohm cm, utilizing 9.6 and 35 kMc/s radiation, are compared with e theory. Results for n-type germanium at 78^{0}K, with μB varied to about 6, agree with the calculated low- and high-field beha- iour. Faraday ellipticity measurements on n-type germanium rystals at 78^{0}K are in qualitative agreement with the theory. In e case of small losses, the sign of the ellipticity is determined by e sign of the quantity $(4\omega\tau - \sigma/\omega\epsilon_{st}')$.

1064 EFFECT OF HEAT TREATMENT ON THE MINORITY-CARRIER LIFETIME IN SILICON.

.A.Atsarkin and E.Z.Mazel'.

iz. tverdogo Tela (USSR), Vol. 2, No, 9, 2089-94 (Sept., 1960). In ussian.

Reports a study of the effect of 400-700^{0}C heat treatment on the inority lifetime in p-type and n-type silicon grown from melt by e Czochralski method. The results obtained on quenching agreed ith those reported by Bemski (Abstr. 7419 of 1956) and by Ross and adigan (Abstr. 6998 of 1958). Annealing after quenching showed at recombination centres are formed not only by high tempera- res but also by quenching. Quenching and annealing affected also tch-pit density. [English translation in: Soviet Physics—Solid tate (USA)]. A.Tybulewicz

SEMICONDUCTING PROPERTIES AND INTERNAL FRICTION N GERMANIUM AND SILICON. See Abstr. 1303

1065 THE EFFECT OF QUENCHING ON THE MINORITY-CARRIER LIFETIME IN SILICON. L.S.Milevskii.

z. tverdogo Tela (USSR), Vol. 2, No. 9, 2158-60 (Sept., 1960). Russian.

Decoration of n-type silicon (by smearing with $CuSO_4$ solution d heating to 700-800^{0}C in hydrogen) produced copper impurity mospheres at dislocations and effectively immobilized the latter. e minority-carrier lifetime of such decorated samples was found be unaffected by quenching from temperatures up to 500^{0}C. nglish translation in: Soviet Physics - Solid State (USA)]. A.Tybulewicz

1066 SURFACE PROPERTIES OF VACUUM CLEANED SILICON. J.T.Law.

Phys. Chem. Solids (GB), Vol. 14, 9-21 (July, 1960).

Measurements of conductivity, photoconductivity and change in ntact potential with light have been made on a sample of floating- ne single-crystal silicon cleaned by positive ion bombardment d annealed. The absence of a conducting p-film after such treat- ent has been demonstrated. The annealing after bombardment s been measured as a function of time at various temperatures. anges in the bulk carrier concentration have been studied after rious heating treatments. Changes in conductivity produced by gon ions indicate that in the clean condition the Fermi level is out 0.1-0.2 eV above the valence band edge. Absorption of atomic hydrogen decreases the conductivity of both heated and bombarded and annealed samples. At the same time ΔCP becomes more negative indicating a downward movement of the energy bands at the surface.

1067 CROSS-SECTIONS OF MIDGAP SURFACE STATES IN SILICON BY PULSED FIELD EFFECT EXPERIMENT.

G.Rupprecht.

J. Phys. Chem. Solids (GB), Vol. 14, 208-13 (July, 1960).

The cross-sections and energy levels of surface states in silicon around midgap have been investigated by a pulsed field effect technique. Two energy levels have been found, one acceptor-like (A), the other one donor-like (D). The results are:

$$(E_C - E_A) = 0.52 \text{ eV}, \ \sigma_n^A = 3 \times 10^{-16} \text{ cm}^2$$

$$(E_A - E_V) = 0.72 \text{ eV}, \ \sigma_p^A = 4 \times 10^{-12} \text{ cm}^2$$

$$(E_D - E_V) = 0.54 \text{ eV}, \ \sigma_p^D = 2 \times 10^{-15} \text{ cm}^2$$

$$(E_C - E_D) = 0.63 \text{ eV}, \ \sigma_n^D = 1 \times 10^{-13} \text{ cm}^2$$

1068 THE SURFACE RECOMBINATION ON SILICON CONTACTING AN ELECTROLYTE. H.U.Harten.

J. Phys. Chem. Solids (GB), Vol. 14, 220-5 (July, 1960).

Excess carriers recombine at the silicon—electrolyte interface in a way not very different from that at dry surfaces. The recombination velocity depends on the surface potential in a bell-shaped manner similar to the "Stevenson-Keyes curve". The surface potential can be varied in a relatively wide range by applying only some tenths of a volt between silicon and electionlyte. A part of the applied voltage drops across the oxide layer present at the silicon surface. This part is larger the thicker the oxide layer in relation to the space charge layer inside the silicon.

1069 SCATTERING OF CONDUCTION ELECTRONS BY LATTICE VIBRATIONS IN SILICON. D.Long.

Phys. Rev. (USA), Vol. 120, No. 6, 2024-32 (Dec. 15, 1960).

A theoretical model which assumes intervalley lattice scattering by phonons of 630^0 and 190^{0}K characteristic temperatures in addition to the usual intravalley acoustic lattice scattering is applied to the results of measurements of electrical conductivity, Hall effect, and weak-field magnetoresistance in the 30^0 to 350^{0}K temperature range in samples of nearly pure n-type silicon. The model gives a good quantitative description of the results when the ratios of the coupling constants for the 630^0 and 190^0 phonons to the coupling constant for acoustic scattering perpendicular to an energy-spheroid axis are, respectively, about 2.0 and 0.15. The coupling constant for acoustic scattering parallel to a spheroid axis was found in an earlier study to be about 1.5 times that for the perpendicular direction. The magnitude of the acoustic contribution to the total lattice scattering mobility, as determined empirically here, is in approximate agreement with the predictions of deformation-potential theory.

1070 PROPERTIES OF SEMICONDUCTIVE BARIUM TITANATES. O.Saburi.

J. Phys. Soc. Japan, Vol. 14, No. 9, 1159-74 (Sept., 1959).

$BaTiO_3$ ceramics were rendered semiconducting by the replacement of a small proportion (0.1 to 0.3%) of Ba or Ti ions by ions of higher valency. Conductivity measurements over a range of temperatures are reported for many specimens, all of which show an anomalous, negative, temperature coefficient of conductivity in the region of the phase transition at 120^{0}C. Other semiconducting properties investigated are thermoelectric power, Hall effect, rectification and the variation of permittivity and a.c. conductivity with frequency and temperature. The discussion deals with the types of ion found to produce conductivity and with the dielectric measurements. K.W.Plessner

1071 THE ELECTRICAL CONDUCTIVITY OF BARIUM TITANATE SINGLE CRYSTALS.

A.Branwood and R.H.Tredgold.

Proc. Phys. Soc. (GB), Vol. 76, Pt 1, 93-8 (July, 1960).

The conductivity of a number of barium titanate single crystals was measured as a function of temperature, applied field, electrode material, thickness and time. Typical results are given, and tentative theories put forward to account for the observed activation energies, the striking non-ohmic nature of the conductivity, and the influence of the electrode material. Results for some doped crystals are also briefly reported.

1072 SEMICONDUCTING PROPERTIES OF Bi—Sb ALLOYS.

S.Tanuma.

J. Phys. Soc. Japan, Vol. 14, No. 9, 1246 (Sept., 1959).

Measurements of Hall constant and resistivity of the alloys were made at temperatures between 4.2° and 300°K. Alloys containing between 4 and 50 atomic percent of Sb showed semiconducting properties. C.Hilsum

INFRARED FARADAY ROTATION AND FREE CARRIER ABSORPTION IN Bi_2Te_3. See Abstr. 1146

1073 BAND STRUCTURE AND ELECTRON TRANSPORT OF GaAs.

H.Ehrenreich.

Phys. Rev. (USA), Vol. 120, No. 6, 1951-63 (Dec. 15, 1960).

Existing experimental data on GaAs are reviewed and analysed to yield the band structure in the vicinity of the band edges as well as the parameters characterizing the bands. On the basis of present experimental evidence, chiefly the behaviour of the optical band gap in Ga(As, P) alloys and the deduced pressure shift and density of states effective mass, it is thought likely that the subsidiary conduction band minima lie along [100] directions. Analytical expressions including nonparabolic effects are given for the energy and density of states of the [000] conduction band and used to obtain a better value of the effective mass from optical reflectivity data. The experimentally observed structure in the Hall effect in n-type material at elevated temperatures is shown to result from excitation of carriers into the subsidiary conduction band. Changes of resistivity with pressure are explained on the basis of an increase of the [000] effective mass at low pressures and the transfer of carriers to the subsidiary minima at higher pressures. The scattering mechanisms, which are important in connection with transport phenomena, are shown to be polar lattice scattering and charged impurity scattering in the highest mobility samples. The transport calculations leading to the mobility and thermoelectric power as a function of temperature and impurity concentrations are performed using variational techniques, and shown to agree well with experiment. The apparently low mobility in the subsidiary minima is attributed at least in part to the large effective mass and relatively small anisotropy ratio. An estimate shows scattering between the two conduction bands probably to be unimportant.

1074 DENSITY OF STATES, EFFECTIVE MASS OF ELECTRONS IN InSb.

Z.Kopeć.

Bull. Acad. Polon. Sci. Ser. Sci. math. astron. phys. (Poland), Vol. 8, No. 2, 105-9 (1960).

Measurements have been made of the thermoelectric e.m.f., conductivity and Hall coefficient of InSb samples with electron concentrations from 2×10^{14} cm^{-3} to 9×10^{18} cm^{-3}, at temperatures from 125 to 500°K. The "classical" concept of a constant effective mass for all carriers is found to be invalid, since InSb exhibits considerable divergencies from the quadratic dispersion law. In analysing the results the effective mass is taken as a variable coefficient depending on the dispersion law and on the kind of phenomenon being considered. These coefficients vary with the carrier concentration and the temperature. Results of the variation of effective mass on carrier concentration, obtained from the observations, are compared with the theoretical predictions based on various scattering mechanisms and a dispersion formula for the InSb conductivity band. J.B.Birks

1075 QUADRATIC DEVIATIONS FROM OHM'S LAW IN n-TYPE InSb.

R.J.Sladek.

Phys. Rev. (USA), Vol. 120, No. 5, 1589-99 (Dec. 1, 1960).

Measurements of the resistivity of n-type InSb of various carrier concentrations were made as a function of electric field strength at low temperatures. The electric fields were kept small enough so that only a slight heating of the electron distribution occurred and the electron mobility μ satisfied the relation $\mu = \mu_0(1 + \beta F^2)$, where μ_0 is the ohmic mobility and F the electric field. Analysis of the experimental values of β yield information about the processes by which electrons lose momentum and energy and about the influence of carrier degeneracy and electron—electron scattering upon these processes. For example, at 4.2°K, piezoelectric scattering is responsible for most of the energy loss, while near 77°K polar optical scattering, enhanced by strong electron—electron scattering, is responsible for energy loss, at least in zero magnetic field. A novel means of changing the sign of the deviation from Ohm's law near 77°K was observed by applying a strong magnetic field.

1076 CARRIER LIFETIME IN INDIUM ANTIMONIDE.

R.A.Laff and H.Y.Fan.

Phys. Rev. (USA), Vol. 121, No. 1, 53-62 (Jan. 1, 1961).

The recombination of excess electron—hole pairs in InSb was studied in the temperature range 200°-15°K, where it is controlled by localized centres. Minority carrier trapping is found in extrinsic p-type material. The lifetimes of electrons and holes obtained from photoconductivity and photoelectromagnetic effect data on n- and p-type samples lead to a model for the recombination, consisting of a donor centre having two energy-levels in the forbidden gap, at 0.055 and 0.12 eV above the valence band. The capture coefficients for holes and electrons were determined for the centre in each of the two charge states. In p-type material, the chemical acceptors are in statistical equilibrium with the free holes in the valence band. When holes freeze out on to acceptor centres ($T < 60°K$), an increase of free holes due to photo-excitation leads to a corresponding increase in the hole concentration on the acceptors. This effect of majority carrier trapping reduces the rise of hole lifetime with decreasing hole concentration. In order to determine the nature of the recombination centres, different treatments were used to introduce additional centres. It was found that bombardment with 4.5 MeV electrons produces additional centres having the same recombination properties as the original centres. The result indicates that the recombination centres have the nature of structural defects rather than chemical impurities.

1077 HALL CONSTANT AND ELECTRON MOBILITY OF InSb, InAs, AND $In(As_{0.8}P_{0.2})$ IN HIGH MAGNETIC FIELDS.

E.Braunersreuther, F.Kuhrt and H.J.Lippmann.

Z. Naturforsch. (Germany), Vol. 15a, No. 9, 795-9 (Sept., 1960). In German.

Measurements were made at room temperature by a pulsed field technique, up to magnetic fields of 180 kOe. The Hall constants of InAs and $In(As_{0.8}P_{0.2})$ are field-independent over the measured range while R for InSb is reduced by 15% at 170 kOe from the room temperature value. The electron mobility of all materials falls sharply with increasing field, so that the Hall angle shows a maximum as a function of magnetic field. C.A.Hogarth

1078 PROPERTIES OF PbSe PREPARED BY POWDER-METALLURGY TECHNIQUES.

J.F.Miller and R.C.Himes.

J. Electrochem. Soc. (USA), Vol. 107, No. 11, 915-19 (Nov., 1960).

The application of powder-metallurgy techniques to the preparation of bulk specimens of lead selenide was studied; both the hot-press and the press-and-sinter methods were employed. Compacting pressure, sintering temperature sintering time, and the particle size of the powder were treated as variables. Electrical and thermoelectric properties, densities, and microstructures of the specimens were studied. Sound specimens of near-theoretical density and with electrical and thermoelectric properties similar to those of the best of cast lead selenide were prepared successfully by the hot-press method. Densities of hot-pressed specimens, which were highest for those prepared at 750°C, 8100 lb/in², were observed to decrease with sintering temperature in the range 750°-450°C, and with compacting pressure in the range 8100-2000 lb/in². The pressed-specimen density was not affected appreciably by variations of sintering time (in the range 5 min-5 hr at 750°C) or variations of the particle size of the powder (in the range −60 to −200 mesh). Electrical properties of specimens with densities in the range 90-98% of theoretical, which were prepared by both the hot-press and the press-and-sinter methods, did not change significantly as density varied in this range.

1079 SURFACE SENSITIVITY OF RECTIFICATION.

V.G.Bhide.

J. Phys. Chem. Solids (GB), Vol. 14, 150-4 (July, 1960).

The diffusion coefficient of sulphur into PbS, FeS_2 and other sulphide semiconductors has been studied as a function of temperature by employing the etching and light profile microscope technique. The penetration of sulphur into an n-type crystal brings about various changes in the electrical parameters of the sample. It is possible to obtain layers with the requisite carrier concentration for the study of photovoltaic effect and transistor action, and both were observed in PbS with a current gain of 0.83 and voltage gain of ~4. With treatment of natural and artificial n-type crystals, a definite improvement in rectifying characteristics was observed. The slope α of the semilog plot of such treated samples is nearly 40 V^{-1} at room temperature as expected from the theory. α is usually found to depend on ϕ which in turn varies from point to point on the crystal surface and from layer to layer in the treated samples. Th oint-sensitivity as observed on the surfaces of a number of crystals s attributed to the crystal imperfections which terminate on the urface. The effect of screw dislocations on the electrical roperties was investigated using SiC crystals. An interesting orrelation of the effect of dislocation on the rectifying character-stics is indicated.

1080 ELECTRICAL STRUCTURE OF PbS FILMS.

D.P.Snowden and A.M.Portis.

hys. Rev. (USA), Vol. 120, No. 6, 1983-95 (Dec. 15, 1960).

The electrical properties of chemically deposited lead sulphide ilms were investigated as a function of frequency from d.c. into the nicrowave range. Conductivity and Hall mobility measurements vere made on both the dark and the photoexcited carriers. The ark conductivity is independent of frequency below 100 Mc/s. It ncreases by almost an order of magnitude over a decade in fre-uency and then becomes constant again at higher frequencies. This behaviour is typical of a material whose low-frequency con-uctivity is limited by barriers. Surprisingly the photoconductivity ehaves quite differently. The photoconductivity has a hump around 00 Mc/s but otherwise is relatively independent of frequency. The Iall mobilities of the dark and photocarriers are equal at d.c. in greement with earlier studies. Microwave Hall measurements ndicate that the dark carriers have about the same apparent mo-ility at 10 kMc/s as at d.c. It is shown that the conventional barrier nodel with a photoinduced change in carrier concentration cannot ccount for the behaviour of these films. Nor can a model in which he barrier height is modified by illumination. The present studies uggest that there are connecting channels through the films and hat the photoresponse of the films is determined by the behaviour f these channels. A simple model is constructed and its para-neters are adjusted to fit the conductivity data and the d.c. Hall nobility. As a check on the model the measured microwave Hall nobility is compared with the predicted value. Good agreement is ound for high-quality commercial films. The hump observed in the hotoconductivity follows naturally from this model being associated vith a modulation of the barrier capacitance. Studies of the photo-onductive decay yield the same time constant at d.c. and micro-vave frequencies, supporting the picture that the same photo-arriers are responsible for the d.c. and microwave photoconduc-ivity.

1081 SCATTERING OF ELECTRONS ON IMPURITY IONS IN LEAD TELLURIDE.

T.S.Stavitskaya and L.S.Stil'bans.

iz. tverdogo Tela (USSR), Vol. 2, No. 9, 2082-4 (Sept., 1960). In ussian.

Shows experimentally that, as in bismuth telluride, the relaxa-ion time of carriers is independent of their energy when they are cattered on impurity ions in PbTe. [English translation in: Soviet hysics—Solid State(USA)]. A.Tybulewicz

1082 ELECTRICAL RESISTIVITY OF NICKEL FERRITE.

H.Lord and R.Parker.

ature (GB), Vol. 188, 929-30 (Dec. 10, 1960).

Nickel ferrites were produced by sintering mixtures of ickelous and ferric oxides under various oxygen pressures up to atm in the temperature range of 1100° to 1250° C. The results of lectrical measurements show that the ferrites produced from a toichiometric oxide mixture are always formed with an oxygen eficiency and are n-type semiconductors. Ferrites made from a ixture $NiO(Fe_2O_3)_{0.95}$ are n-type conductors at low and p-type onductors at high oxygen sintering pressures, respectively. N-type onduction involves electrons on divalent iron ions and p-type con-ction is by positive holes on trivalent nickel ions. The change ver in conductivity type as a function of oxygen pressure is associ-ed with a peak in the activation energy and corresponds presumably a loss of oxygen atoms equal to one half of the number of excess ckel ions dissolved. R.Parker

1083 THE HOLE MOBILITY IN SELENIUM.

W.E.Spear.

roc. Phys. Soc. (GB), Vol. 76, Pt 6, 826-32 (Dec. 1, 1960).

A pulse method, developed for the study of effective mobility in sulating solids, was applied to evaporated specimens of vitreous e. Charge carriers were generated near the top electrode by a 3 mμsec electron pulse and drifted across the specimen in a pulsed plied field. The transit time of holes was measured with impro-ed electronic apparatus having a bandwidth of 27 Mc/s. At 20° C e effective hole mobility μ lies between 0.13 and 0.14 $cm^2 sec^{-1} V^{-1}$. he temperature dependence of μ shows that it is controlled by a vel of acceptor states lying $\epsilon \approx 0.14$ eV above the valence band. The values of μ and ϵ were in close agreement with those found for single crystal of hexagonal Se which suggested that the centres controlling μ are common to both forms of Se. It was concluded that the hole conduction is determined by the short-range order within the Se chain itself or in close proximity to it. The carrier density, however, depends on the arrangement of the chains in the solid. From X-ray data the density of acceptor states was estimated as $10^{20} cm^{-3}$, giving a value of about 60 $cm^2 sec^{-1} V^{-1}$ for the microscopic mobility.

1084 THE ELECTRICAL CONDUCTIVITY OF SYNTHETIC RUTILE MONOCRYSTALS.

W.Kleber, H.Peibst and W.Schröder.

Z. phys. Chem. (Germany), Vol. 215, No. 1-2, 63-76 (1960).

Measurements of electrical conductivity σ of monocrystals of TiO_2, prepared by the Verneuil process, were made as functions of temperature and of the degree of reduction. For strongly reduced TiO_2, σ is temperature independent. For yellowish-white (unreduced) crystals, σ is of order 10^{-6}-10^{-7} $ohm^{-1} cm^{-1}$; for darkish (heavily reduced) crystals, σ is of order 10^{-3} to 1 $ohm^{-1} cm^{-1}$. The activation energy decreases with increasing degree of reduction. TiO_2 is an n-type semiconductor with vacancies in the oxygen lattice. An energy scheme is derived from the experimental results showing the levels corresponding to different degrees of oxygen reduction.
C.A.Hogarth

1085 HOT HOLES IN TELLURIUM.

Y.Kanai.

J. Phys. Soc. Japan, Vol. 14, No. 8, 1118 (Aug., 1959).

From measurements of the current—voltage characteristic and Hall coefficient of Te single crystals in pulsed electric fields at 77° K, it is concluded that the mechanism of energy loss of holes is acoustic-phonon scattering: the contribution from optical-phonon interaction appears to be negligible. G.C.Williams

1086 FEATURES OF THE DEPENDENCE OF ENERGY GAP AND CARRIER MOBILITY ON COMPOSITION OF TELLURIUM--SELENIUM AND TELLURIUM-SULPHUR SOLID SOLUTIONS.

V.N.Lange and A.R.Regel'.

Fiz. tverdogo Tela (USSR), Vol. 2, No. 10, 2439-45 (Oct., 1960). In Russian.

The authors measured energy gap and hole mobility as functions of selenium and sulphur concentration for dilute solid solutions. The mobility was deduced from measurements of conductivity and Hall coefficient. An anomalous rise in mobility was observed for ~0.05% Se in Te at 90° K and for ~0.05% S in Te at 90° K but there was no rise at room temperature in either case. The magnetoresistance of the samples was also measured. [English translation in: Soviet Physics—Solid State (USA)].
M.G.Priestley

1087 THE ISOELECTRONIC SERIES OF SEMICONDUCTING COMPOUNDS WITH THE ZINC-BLENDE STRUCTURE.

A.Raychaudhuri.

Proc. Nat. Inst. Sci. India A, Vol. 25, No. 4, 201-5 (July 26, 1959).

Presents an attempt to explain the regularities observed in the properties of this series, on the basis of a model developed by Engelmann and the present author. The increase of energy gap and the monotonic decrease of hole mobility with increasing charge difference between constituent nuclei are successfully explained. There is also some indication that the exceptionally large electronic mobility in III-V compounds may find an explanation.

1088 SEMICONDUCTING FILMS OF ZrO_2.

A.Ya.Kuznetsov and L.A.Pafomova.

Fiz. tverdogo Tela (USSR), Vol. 2, No. 10, 2567-9 (Oct., 1960). In Russian.

Introduction of Sn and Bi atoms into the ZrO_2 lattice produced a semiconducting material with an electrical resistivity of 10-10^3 ohm cm at 20° C. Thin layers of this material had high chemical and mechanical stability, were transparent in the visible region, and their surface conduction was 10^{-6}-10^{-8} ohm^{-1}. [English translation in: Soviet Physics—Solid State (USA)]. A.Tybulewicz

Semiconductor Devices

1089 MEASUREMENT OF THE INJECTION EFFICIENCY OF THE EMITTER POINT CONTACT ON GERMANIUM IN THE PRESENCE OF A DRIFT FIELD.

M.Szilágyi.

Acta phys. Hungar., Vol. 11, No. 4, 401-4 (1960).

1090 INVESTIGATION OF THE BARRIER CAPACITANCE OF DIFFUSED P—N JUNCTIONS IN SILICON.

L.S.Berman and V.K.Subashiev.
Fiz. tverdogo Tela (USSR), Vol. 2, No. 8, 1962-5 (Aug., 1960).
In Russian.

Reports the dependence of the barrier capacitance of diffused p—n junctions in silicon on the applied voltage (V) and temperature. The dependence on the applied voltage was

$$C_b = \sqrt[n]{\frac{k}{V_k - V}}$$

where V_k is the barrier potential and $2 \leq n \leq 3$. The barrier capacitance increased with increase of temperature but the dependence on temperature was reduced on increase of the applied voltage in the blocking (reverse) direction. The barrier capacitance fell on increase of frequency at low temperatures. A.Tybulewicz

1091 THE EFFECT OF CARRIER GENERATION IN THE BARRIER LAYER ON THE REVERSE CURRENT—VOLTAGE CHARACTERISTICS OF GERMANIUM DIODES.

N.A.Belova, A.N.Kovalev and N.A.Penin.
Fiz. tverdogo Tela (USSR), Vol. 2, No. 10, 2647-54 (Oct., 1960).
In Russian.

Reports an experimental study of the effect of carrier generation in the barrier layer on the reverse current in germanium diodes. Shows that such carrier generation may affect appreciably the form of the reverse current—voltage characteristic. Reports that carrier generation is practically non-existent in the barrier layers of diodes prepared by alloying of indium with nickel-doped germanium, because nickel is extracted from the barrier-layer region. [English translation in: Soviet Physics—Solid State (USA)]. A.Tybulewicz

1092 PIEZOELECTRIC EFFECT IN A RECTIFYING CONTACT OF A SEMICONDUCTOR.

T.Tanaka and H.Kawamura.
J. Phys. Soc. Japan, Vol. 14, No. 10, 1455 (Oct., 1959).

The space charge layer of a p—n junction may be expected to resemble a condenser microphone. When mechanical force is applied to the device an e.m.f. will therefore appear between the two electrodes. Experiments using a $BaTiO_3$ transducer to "drive" a selenium rectifier indicate that a significant e.m.f. arises from this process. C.A.Hogarth

1093 VISIBLE LIGHT EMISSION FROM GERMANIUM DIFFUSED P—N JUNCTION.

M.Kikuchi and K.Tachikawa.
J. Phys. Soc. Japan, Vol. 14, No. 12, 1830 (Dec., 1959).

A germanium crystal was melted in a quartz crucible, kept at 1450° C for 15 min, and a single In-doped crystal pulled in the $\langle 111 \rangle$ direction, this treatment being chosen to enrich the crystal with oxygen. The crystal was sliced, a 1 μ n-type layer introduced by As diffusion, and a small p—n junction area made by mask-etching. Visible light emission was observed at the periphery of this junction. J.B.Birks

1094 INFRARED RADIATION FROM SILICON GROWN JUNCTION.

I.Uchida.
J. Phys. Soc. Japan, Vol. 14, No. 12, 1831 (Dec., 1959).

Recombination radiation from a Si p—n junction was observed at a current flow >100 mA, (clearly seen at 300 mA) using a 1P25 image tube with Ag—Cs photocathode. A microphotometer plot of the film density shows the radiation intensity to fall to 1/e of its peak (at the junction) in the n-region in about 300 μ, comparable with the diffusion length of the radiative carriers. The emission observed in the p-region, which falls away sharply, is attributed to light scattering. J.B.Birks

1095 PHOTOVOLTAIC EFFECT PRODUCED IN SILICON SOLAR CELLS BY X- AND GAMMA RAYS.

K.Scharf.
J. Res. Nat. Bur. Stand. (USA), Vol. 64A, No. 4, 297-307 (July-Aug., 1960).

The open-circuit voltage and photocurrent produced in a silicon solar cell by X- and gamma rays were measured as a function of exposure dose rate, cell temperature, angle of incidence of radiation, and photon energy. This photoresponse was stable and proportional to the exposure dose rate, which was applied up to a maximum of 1.8×10^6 r/min for X-rays and 4×10^2 r/min for Co^{60} gamma rays. At an exposure dose rate of 1 r/min the response was of the order of 10^{-5} V for the open-circuit voltage and 10^{-8} A for the photocurrent. At high exposure dose rates of Co^{60} gamma rays, radiation damage became apparent. The temperature dependence of the photoresponse was controlled by the temperature dependence of the cell resistance. The directional dependence of the photoresponse varied with the quality of radiation and for Co^{60} gamma rays was very small for angles from 0° to 70°. The photoresponse decreased with increasin photon energy but changed only little between 200 and 1250 keV. Th ratio of the response to X-rays of 38 keV effective energy and that to Co^{60} gamma rays was approximately 6 : 1. An approximate value of the thickness of the effective p—n junction layer is deduced from the energy dependence.

1096 EVALUATION AND CONTROL OF DIFFUSED IMPURITY LAYERS IN GERMANIUM.

H.S.Veloric and W.J.Greig.
RCA Rev (USA), Vol. 21, No 3, 437-56 (Sept , 1960).

The calculations reported are for n- and p-type impurities with a complementary-error-function distribution in uniformly doped germanium of the opposite conductivity. These methods are then used to evaluate a new solid-phase diffusion process employing a powdered-germanium alloy doped with a known impurity concentration as the diffusant The surface concentration of a diffused layer is shown to be approximately equal to the concentration in the source powder at high temperature and to decrease with decreasing temperature. Diffusion constants for arsenic and antimony are determined by use of "sheet-resistance" and junction-penetration measurements Because the surface concentration can be predicted within a factor of two, and the penetration within ten per cent, the present experiments show that the powder diffusion method is suitable for the fabrication of carefully controlled impurity layers.

1097 SEMICONDUCTOR AMPLIFIERS AND GENERATORS WITH CARRIERS HAVING NEGATIVE EFFECTIVE MASS.

N.G.Basov, O.N.Krokhin and Yu.M.Popov.
Zh. eksper. teor. Fiz. (USSR), Vol. 38, No. 3, 1001-3 (March, 1960).
In Russian.

It is shown that in a constant electric field it is impossible to achieve a state with negative losses (carriers giving up energy to the field). This would require $\partial f/\partial \epsilon > 0$, and in thermodynamic equilibrium this is always <0. A state with negative temperature is necessary produced either by monochromatic irradiation or by pulsed excitation by an electric field In the latter case interband transitions will be more efficient than intraband, since the lifetime of negative temperatures are considerably shorter in the latter. [English translation in: Soviet Physics — JETP (USA), Vol. 11, No. 720-1 (Sept., 1960)]. R.Berma

1098 ON THE QUESTION OF NEW POSSIBILITIES OF AMPLIFICATION BY THE MOVEMENT OF CARRIERS IN SEMICONDUCTORS.

E.Groschwitz.
Z. angew. Phys. (Germany), Vol. 12, No. 9, 400-10 (Sept., 1960).
In German.

See Abstr. 15919 of 1960. The possibility of high-frequency collective motion in the mm and sub-mm regions of mobile charge carriers in semiconductors is discussed. J.Frank

1099 INTEGRATION OF CIRCUIT FUNCTIONS INTO SOLIDS

S.W.Herwald and S.J.Angello.
Science (USA), Vol. 132, 1127-33 (Oct. 21, 1960).

Review article on the trend in electronic circuit construction towards microminiaturization and molecular electronics.

Photoconductivity

1100 A NEW METHOD OF DETERMINING THE EFFECTIVE CROSS-SECTIONS OF LOCALIZED CENTRES.

É.I.Adirovich.
Fiz. tverdogo Tela (USSR), Vol. 2, No. 9, 2248-51 (Sept., 1960).
In Russian.

Proposes a method in which the non-stationary voltage across a crystal is measured when a periodic or pulsed illumination is applied. The stationary concentration of electrons and not that of the centres is required. The conditions under which the method wi work are given. [English translation in: Soviet Physics—Solid Sta (USA)]. R.Berma

1101 THEORY OF PHOTOMAGNETIC EFFECTS IN SEMICONDUCTORS WITH COMPLEX ENERGY BANDS.

Yu.I.Ravich.
Fiz. tverdogo Tela (USSR), Vol. 2, No. 10, 2366-9 (Oct., 1960).
In Russian.

The author calculates the magnitude of the effect for an bitrary uniform field. Comparison of the results with those of clotron resonance gives information on the angular variation of laxation time. [English translation in: Soviet Physics—Solid ate (USA)]. M.G.Priestley

1102 KINETICS OF IMPURITY PHOTOCONDUCTIVITY AND EFFECTIVE CROSS-SECTIONS OF LOCAL CENTRES.

I.Adirovich.

z. tverdogo Tela (USSR), Vol. 2, No. 10, 2384-94 (Oct., 1960). Russian.

Discusses theoretically the kinetics of impurity photoconducti- ty in the case of a unipolar perturbation of a semiconductor, i.e. ien non-equilibrium carriers are generated in the majority-conduc- on band. Distributions of the field, current and space charge are tained, as well as densities of free and bound carriers. Decay of e potential across a semiconducting crystal, related to impurity otoconductivity transients, is discussed. It is shown how to obtain ch experimental conditions that the photoconductivity kinetics in a ystal containing several types of local level is governed by elec- on exchange between the majority conduction band and levels of one pe only. A new method is given of determining effective cross- ctions for capture of electrons or holes at the levels of singly and ultiply charged local centres. This method can be used in studies both recombination levels and trapping levels. [English transla- on in: Soviet Physics-Solid State (USA)]. A.Tybulewicz

1103 INVESTIGATION OF THE SPECTRAL DEPENDENCE OF THE PHOTOCONDUCTIVITY OF MONOCRYSTALLINE dSe AT 77° AND 20°K. V.V.Eremenko.

z. tverdogo Tela (USSR), Vol. 2, No. 10, 2596-601 (Oct., 1960). In issian.

Several single crystals were examined. The results are com- red with the absorption spectrum, for the same material, obtained 20°K. The positions of some of the maxima in the photocurrent ectrum are found to be temperature dependent. [English trans- tion in: Soviet Physics—Solid State (USA)]. K.N.R.Taylor

1104 INVESTIGATION OF THE SPECTRAL DISTRIBUTION OF THE PHOTOCONDUCTIVITY OF MIXED SINGLE RYSTALS OF $CdS_x.CdSe_{1-x}$ AT 77°K AND 20°K. V.V.Eremenko.

iz. tverdogo Tela (USSR), Vol. 2, No. 10, 2602-5 (Oct., 1960). Russian.

The spectral distribution of the photoconductivity of single ystals of CdS and CdSe and two kinds of mixed crystals was in- stigated at 77°K and 20°K. At 77°K, on going from pure CdS to ıre CdSe via the mixed crystals, the spectral distribution curves tained the same features, but the peaks were displaced towards e low frequency side. At 20°K the peaks were intensified and idened. The absorption spectra of the four substances at 20°K ere also obtained. Using his own results and those of others, the thor concludes that the displacement of an absorption edge is only ightly affected by a change in the interatomic distance. [English anslation in: Soviet Physics—Solid State (USA)]. N.Davy

1105 MODULATED LIGHT METHOD FOR MEASURING THE CAPTURE CROSS-SECTION OF TRAPS IN ADMIUM SULPHIDE. E.A.Niekisch.

Phys. (Germany), Vol. 161, No. 1, 38-45 (1960). In German.

An extension of a method previously describes (Abstr. 6147-8 1955) is used to determine capture cross-sections or shallow aps in the vicinity of the conduction band. The data are obtained om measurements of the photoconductivity induced by sinusoidally odulated light of $\lambda \cong 600$ mμ. The results are as follows: $\sigma \cong 1.5$ 6×10^{-16} cm² for traps at 0.12 eV (below the conduction band); $\cong 5$ to 9×10^{-15} cm² for traps between 0.2 and 0.6 eV $\sigma \cong 10^{-14}$ to $^{-13}$ cm² for traps at 0.7 to 0.8 eV.

1106 SURFACE PROPERTIES OF PbS PHOTOCONDUCTORS.

J.N.Zemel and J.O.Varela.

Phys. Chem Solids (GB), Vol. 14, 142-9 (July, 1960).

A study of the field effect trapping time constant as a function temperature has been carried out on a series of lead sulphide otodetectors. The results show that the density of field effect ıps (or surface traps) does not vary appreciably but that the rrier concentration increases as the sensitivity of the films creases. The mobilities obtained from the high frequency field ect measurement agree quite well with Hall data on similar films. e rate of capture of the holes (for majority carriers) was latively independent of the films whereas the rate of emission of les from the surface levels increased with increasing sensitivity. A simple Shockley—Read model does not explain the various phenomena adequately. However, the general picture of majority carrier photoconductivity is substantiated by these measurements.

1107 MEASUREMENTS ON SOME PHOTOCONDUCTIVE CELLS IN THE INFRARED.

N.Louisnard and A.Girard.

Rev. Opt. (France), Vol. 38, No. 12, 556-62 (Dec., 1959). In French.

PbS, PbTe and PbSe photocells were investigated over the range 1-6 μ. A double rock-salt prism monochromator was used for measuring the spectral sensitivity. The apparatus described ensures a suitable frequency response up to 30 kc/s. The minimum detectable energy was determined for a monochromatic flux at the maximum spectral sensitivity of each photocell. The results are tabulated.

1108 MEASUREMENT OF THE MOBILITY OF PHOTO-CURRENT CARRIERS IN ADDITIVELY-COLORED KCl CRYSTALS. N.P.Kalabukhov and V.G.Sidyakin.

Fiz. tverdogo Tela (USSR), Vol. 2, No. 10, 2589-93 (Oct., 1960). In Russian.

The mobility, deduced from measurements of the Hall angle, was found to be 1.5 cm² V^{-1} sec^{-1}, decreasing slightly when the crystal was subjected to X-irradiation and F-band illumination. This is compared with the polaron theory of Pekar in which an effective mass of $163m_e$ and mobility of 3.1 cm² V^{-1} sec^{-1} are deduced. Curves are given for the absorption between 350 and 900 mμ. [English translation in: Soviet Physics—Solid State (USA)]. D.J.Huntley

1109 INVESTIGATION OF THE INFLUENCE OF CRYSTALLINE ORIENTATION OF SILICON ON THE PROPERTIES OF PHOTOCONVERTERS.

A.Ya.Gliberman and O.P.Fedoseeva.

Fiz. tverdogo Tela (USSR), Vol. 2, No. 10, 2585-8 (Oct., 1960). In Russian.

The light and dark volt-amp curves are determined for n- and p-type silicon photoelements cut in the crystalline planes (111), (110), and (100). Resistance, voltage and current characteristics derived from these curves are tabulated. The effect of orientation on the properties is small. [English translation in: Soviet Physics-Solid State (USA)]. R.F.S.Hearmon

1110 A DIRECT PROOF FOR THE MIGRATION OF HOLES IN SILVER CHLORIDE.

J.Kluge, O.Stasiw and P.Süptitz.

Z. Phys. (Germany), Vol. 160, No. 4, 363-74 (1960). In German.

By using the Haynes—Shockley electric field impulse method (Abstr. 6959 of 1951), the properties of photoelectrons from AgCl are examined. A region is found in which no print-out effect occurs but in which photoelectrons are produced. The region lies immediately under the crystal surface with sharp boundaries, its width increasing with the applied electric field. The holes produced in this region are assumed to move further into the crystal and to destroy the silver formed. The effect only occurs in crystals which have been annealed in air or oxygen. It would seem that the silver vacancies are hole traps. Addition of divalent cations which promote silver vacancies, appears to produce cavities under the surface which might be treated as large complexes of V centres. G.F.J.Garlick

1111 MIXED ZnS.CdS MONOCRYSTALS AND SOME OF THEIR PROPERTIES. N.I.Vitrikhovskii and I.B.Mizetskaya.

Fiz. tverdogo Tela (USSR), Vol. 2, No. 10, 2579-84 (Oct., 1960). In Russian.

These crystals had a hexagonal lattice of the wurtzite type and were substitutional solid solutions with unlimited mutual solubility of the two components. Variation of the component ratio shifted gradually the maximum on the spectral response curve of the photoconductivity. For pure CdS this maximum lay at 5100 A, and for pure ZnS it was at 3400 A; at any intermediate composition the maximum lay between these two limits. The composition affected also the forbidden bandwidth. [English translation in: Soviet Physics—Solid State (USA)]. A.Tybulewicz

Thermoelectric Properties

1112 THEORY OF THERMOELECTRIC POWER OF IONIC CRYSTALS. II. E.Haga.

J. Phys. Soc. Japan, Vol. 14, No. 8, 992-6 (Aug., 1959).

For Pt I, see Abstr. 12313 of 1959. Expressions are obtained for the thermoelectric power of NaCl doped with $CdCl_2$ and Cl_2 gas electrodes. The Coulomb interaction between defects in NaCl and in AgBr is taken into account and an estimation is made of correction terms to the simple theory. The relation between the thermoelectric power with metallic electrodes and with halogen electrodes is derived, and the results compared with experiments with silver and lead halides. J.Franks

1113 THEORY OF THERMOELECTRIC POWER OF IONIC CRYSTALS. III. E.Haga.

J. Phys. Soc. Japan, Vol. 14, No. 9, 1176-81 (Sept., 1959).

When a temperature gradient is established across a AgCl crystal doped with CuCl, the thermoelectric power changes and reaches a steady value, because of the diffusion of Cu^+ ions. On removal of the gradient, the original conditions are reverted to as the Cu^+ ions diffuse back to uniform distribution. Expressions for these processes are derived and time constants estimated from conductivity data. J.Franks

1114 THERMOELECTRICITY AT LOW TEMPERATURES. VIII. THERMOELECTRICITY OF THE ALKALI METALS BELOW 2°K.

D.K.C.MacDonald, W.B.Pearson and I.M.Templeton.

Proc. Roy. Soc. A. (GB), Vol. 256, 334-58 (July 5, 1960).

In Pt VII (Abstr. 2916 of 1960) the absolute thermoelectric power (S) of all the alkali metals was measured directly between 2 and 20°K. Measurements were now made of the absolute thermoelectric force, E, of all the alkali metals below 2°K and down to about 0.1°K by means of adiabatic demagnetization techniques. The absolute thermoelectric power, S, was derived with fair accuracy from these results ($S = dE/dT$). The results are compared with theoretical developments, particularly those of Bailyn and Ziman.

1115 THE THERMAL CONDUCTIVITY AND THERMOELECTRIC POWER OF BISMUTH TELLURIDE AT LOW TEMPERATURES. P.A.Walker.

Proc. Phys. Soc. (GB), Vol. 76, Pt 1, 113-26 (July, 1960).

Measurements were made of the thermal conductivity and thermoelectric power of a range of single-crystal samples of p- and n-type Bi_2Te_3 between 6 and 200°K. The observed lattice conductivity could be interpreted in terms of scattering by the tellurium isotopes. Measurements on the iodine-doped samples showed the existence of appreciable impurity scattering. Interpretation of the thermoelectric power results suggests a multiband structure for Bi_2Te_3.

1116 THERMOELECTRIC POWER OF DILUTE COPPER AND SILVER ALLOYS.

F.J.Blatt, M.Garber, R.H Kropschot and B.Scott.

Austral. J. Phys., Vol. 13, No. 2a, 223-37 (July, 1960).

Solid State Physics Conference (see Abstr. 17864 of 1960). Measurements of the thermoelectric power of several dilute copper and silver alloys are reported. The thermoelectric powers of the alloys were measured between about 8 and 350°K. The results were analysed using the Mott—Friedel relation. It was found that good agreement between the calculated and measured thermoelectric powers could be obtained only if it was assumed that the absolute thermoelectric power of pure copper and pure silver consists of two contributions: one, the usual free-electron contribution and another, which is believed to be due to phonon drag. This phonon drag contribution is of the correct magnitude and shows the expected temperature dependence. Moreover, the effect of alloying on the phonon-drag contribution is in agreement with theoretical estimates.

1117 AN EXPERIMENTAL STUDY OF THE TWO KELVIN RELATIONS. I.K.Kristensen.

Fiz. tverdogo Tela (USSR), Vol. 2, No. 10, 2641-2 (Oct., 1960). In Russian.

The second relation between Peltier coefficient and thermoelectric force per degree, $P = \alpha T$ is shown to hold within the experimental accuracy (2%) for n-type Ge single crystals between -80° and 0°C. (Impurity conduction dominant over the whole range). [English translation in: Soviet Physics—Solid State (USA)]. R.Berman

Dielectric Properties

1118 ELECTROMAGNETIC PROPERTIES OF INSULATORS. II. V.Ambegaokar.

Phys. Rev. (USA), Vol. 121, No. 1, 91-104 (Jan. 1, 1961).

This paper is a continuation of an earlier study (Abstr. 5260 of 1960), from a many-particle point of view, of the electromagnetic properties of insulators. Here the system of an insulator and one electron is treated. The Coulomb interactions between all the electrons in the system are allowed for to all orders of perturbatio theory. The true effective mass, m*, of the extra particle is defined a the curvature in wave vector space of the energy surface connectin the ground state and the low-lying excited states of the interacting system. The central result then obtained is that the response of the system to long-wavelength, low-frequency electric fields is exactly that of a free electron of mass m* moving in a medium characterized by the dielectric constant of the perfect insulator. The energy levels of the system in a static magnetic field are also discussed. An alternative derivation of a single-particle effective-mass equati previously obtained by Klein, is given. The eigenvalues of this equation are under certain conditions the energy levels of the interacting system in a magnetic field. In an appendix a Kramers—Kron relation connecting the difference in optical absorption of the prese system and the perfect insulator with m* is derived. These results indicate that the usual effective-mass theory of semiconductors of low carrier concentration includes the effects of the electron—electron interactions to an excellent approximation.

1119 INFLUENCE OF CRYSTALLOGRAPHIC ORIENTATION ON THE SEPARATION OF CHARGES DURING PHASE CHANGE (COSTA RIBEIRO EFFECT).

L.G.Freitas and S.Mascarenhas.

An. Acad. Brasil.Cienc., Vol. 32, No. 1, 17-23 (1960). In Portuguese

See Abstr. 6762 of 1953. Results of some measurements on C_8H_{10}(otherwise referred to as $C_{10}H_8$) are given. A.R.Stokes

1120 SPACE CHARGE POLARIZATION AND DIELECTRIC AFTER-EFFECT IN GLASS. K.Blank and A.Hersping.

Naturwissenschaften (Germany), Vol.47, No. 17, 391-2 (1960). In German.

Dielectric measurements on a soda-lime glass are reported, extending over the frequency range 0.5 c/s to 5 Mc/s and the temperature range 20 to 500°C. At high temperatures, a steep ris in permittivity with falling frequency was found, which was interpreted in terms of space-charge layers at the anode. A relaxation effect was also observed at higher frequencies, whose activation energy agreed with that of the d.c. conductivity, and which was attri buted to the movement of Na ions. K.W.Plessne

1121 A NOTE ON THE THEORY OF SPACE-CHARGE LIMITED CURRENTS.

C.Rhys-Roberts and R.H.Tredgold.

Proc. Phys. Soc. (GB), Vol. 76, Pt 4, 497-501 (Oct. 1, 1960).

In order to explain the observed non-ohmic conductivity in barium titanate and cadmium sulphide, it is necessary to assume that the current is space-charge limited. Previous work on space charge limited currents has failed to predict the correct thickness dependence. In this paper a model is proposed wherein there are thin layers of uncharged traps at the surface of a dielectric, uniformly distributed in space and of one energy depth; the bulk of the material contains no traps. Using this model the observed experimental results can be explained.

1122 MEASUREMENT OF DIELECTRIC CONSTANT OF GERMANIUM AT MICROWAVE FREQUENCIES.

T.Fukuroi and K.Yamagata.

Sci. Rep. Res. Insts Tohoku Univ. A (Japan), Vol. 11, No. 4, 285-95 (Aug., 1959).

The dielectric constant and electrical conductivity of germanium were measured at microwave frequencies in the temperature range from 1.6° to 300°K by the resonant cavity method. The observed values of dielectric constants showed the size effect, and were corrected by taking the depolarizing field into account. The imaginary or reactive part of the conductivity appeared as a reduc tion of the effective dielectric constant. The temperature depende of the relaxation time of charge carriers was estimated by using th simple classical relaxation formula.

1123 INVESTIGATION OF DIELECTRIC LOSSES IN SOLID DIELECTRICS AT HIGH FREQUENCIES.

A.Vodop'yanov and G.I.Galibina.
v. Akad. Nauk SSSR, Ser. Fiz., Vol. 24, No. 2, 142-9; Disc. 167-9
960). In Russian.

"1958 Moscow Dielectrics Conference" (see Abstr. 16003 of
60). The variation of dielectric loss angle with frequency and
mperature was determined for some alkali halide crystals.
easurements made on KCl show that in the presence of added
ıpurities the temperature—frequency dependences of a tan δ are
milar to those in simple crystals. Some impurities result in
creased tan δ and this is due to an increase in the number of free
d weakly bound ions. Dielectric loss in crystals of solid solutions
due to ohmic and relaxation losses and is similar to that in
mple crystals. Z.Krasucki

1124 FURTHER ELECTRICAL EFFECTS OF THE ADSORPTION OF WATER VAPOUR BY ANODIZED ALUMINIUM.

.J.L.Booker and J.L.Wood.
roc. Phys. Soc. (GB), Vol. 76, Pt 5, 721-31 (Nov., 1960).

Measurements were made of the equivalent parallel capacitance
ıd resistance of porous anodized aluminium oxide layers. The
easurements, made in air at relative humidities from 0.0 to 0.85
ıd at frequencies from 50 c/s to 1 Mc/s, extended up to 433 days
ter formation of the anodic layer. The influence of the humidity
ıd of the frequency of measurement of the dielectric properties of
ese layers may be explained satisfactorily on the basis of an
ıuivalent circuit. The variation in properties found among layers
ıodized in the same conditions is due to differences in conductivity
rising from varying amounts of stray ions incorporated in the
yers. Ageing is primarily due to a decrease in conductivity, and
ot to structural changes of the oxide layer. The ageing may be
versed by brief immersion of the layers in electrolytes. The
esults indicate that, in addition to the dielectric losses arising
om the main porous structure, losses also occur within the
norphous alumina, showing that this is permeable to water. This
n account for measurements of the surface area of porous anodic
yers, and of the humidity dependence of the losses in "non-porous"
ıodic layers.

1125 THE STRUCTURE AND RELAXATION OF DIELECTRICS. C.P.Smyth.

Electrochem. Soc. (USA), Vol. 107, No. 10, 855-8 (Oct., 1960).

A brief but authoritative review of theory and experiment on the
bject of bipolar relaxation times. The behaviour of polar mole-
les in non-polar solvents, as well as of polar crystalline solids,
e treated. K.W.Plessner

1126 THE DISTRIBUTION OF RELAXATION TIMES IN THERMAL IONIC POLARIZATION. V.N.Lozovskii.

iz. tverdogo Tela (USSR), Vol. 2, No. 10, 2540-3 (Oct., 1960). In
ussian.

The author considers the theory of thermal ionic polarization
r an arbitrary number of identical potential wells. The distri-
ıtion of dielectrically active relaxation times is found and it is
ıown that the basic characteristics of the phenomenon are sensi-
ve to the number of wells taken. [English translation in: Soviet
hysics—Solid State (USA)]. M.G.Priestley

1127 RELAXATION TIME AND DISTRIBUTION FUNCTION OF QUASI-DIPOLES IN IONIC CRYSTALS WITH DE-
ECT STRUCTURE. G.N.Skanavi.

v. Akad. Nauk SSSR, Ser. fiz., Vol. 24, No. 2, 124-31; Disc. 135-6
960). In Russian.

"1958 Moscow Dielectrics Conference" (see Abstr. 16003 of
60). The modifications to the simple Debye theory required to
count for the dielectric behaviour of ionic crystals containing de-
:ts are analysed. It is concluded that the distribution of relaxa-
n times is unsymmetrical. Assuming the activation energy of the
ısi-dipoles resulting from the defects, and the width of the energy
rrier are both power functions of distance, and that the defect con-
ntration is low, expressions are obtained for the distribution func-
n and for the real and imaginary components of the permittivity.
e effect of high defect concentration is briefly considered.
R.F.S.Hearmon

1128 THE INTENSITY OF DIELECTRIC ABSORPTION IN ALKALI HALIDES AS A FUNCTION OF THE CONCEN-
ATION OF DIVALENT CATION IMPURITIES.

.Cook and J.S.Dryden.
stral. J. Phys., Vol. 13, No. 2a, 260-9 (July, 1960).

Solid State Physics Conference (see Abstr. 17864 of 1960). The dielectric absorption of sodium chloride containing calcium, and potassium chloride containing strontium, was measured as a function of concentration of the divalent impurity. From the intensity of the absorption it was possible to estimate accurately the number of divalent impurity cations associated with positive ion vacancies so as to form dipoles. In both systems at equilibrium at room temperature it was found that a large proportion of the divalent impurity ions were associated with the positive ion vacancies in a higher complex than a dipole. By quenching from different temperatures, an investigation of the equilibria between divalent impurities, vacancies, dipoles, and higher complexes was made. The kinetics of the aggregation of the dipoles was studied for the NaCl(Ca^{++}) system.

1129 THE PHOTODIELECTRIC EFFECT IN ZnS:Cu:Co PHOSPHORS. F.I.Vergunas and G.M.Malkin.

Fiz. tverdogo Tela (USSR), Vol. 2, No. 9, 2322-9 (Sept., 1960). In Russian.

Between 200 and 5 × 10^6 c/s, the photodielectric effect (change of permittivity and tan δ on ultraviolet illumination) was mainly due to conduction processes in crystal grains. These processes explained the range of relaxation times and the dependence of the change of permittivity in d.c. fields on temperature and on the exciting-light intensity. [English translation in: Soviet Physics—Solid State (USA)]. A.Tybulewicz

1130 THE NATURE OF THE TRANSIENT PHENOMENA OF CONDUCTIVITY IN FERROELECTRICS.

V.M.Gurevich, I.S.Zheludev and I.S.Rez.
Fiz. tverdogo Tela (USSR), Vol. 2, No. 4, 691-6 (April, 1960).
In Russian.

A previous paper (Abstr. 13658 of 1960) demonstrated certain transient phenomena in barium titanate and related these to ferroelectric polarization. The present paper reports further investigations on both single crystal and polycrystalline material in order to determine the mechanism of these phenomena. [English translation in: Soviet Physics—Solid State (USA)].
A.E.I. Research Laboratory

1131 FREE ENERGY OF 180° [DOMAIN] WALLS AND SURFACES IN THE BODY-CENTRED CUBIC DIPOLE LATTICE. H.Sommerhalder.

Helv. phys. Acta (Switzerland), Vol. 33, No. 6-7, 617-26 (1960).
In German.

The free energy in ferroelectrics is estimated, assuming a simple model of the dipole interaction in a b.c.c. lattice. The wall and the surface layer are found to be about one lattice constant thick, except for temperatures very close to the Curie temperature. Spontaneous polarization in the surface layer is found to have lower values than in the undisturbed crystal for all temperatures.

1132 THE DIELECTRIC PROPERTIES OF CERAMIC BARIUM TITANATE BETWEEN 50 kc/s AND 25 Mc/s.

G.Déjardin, G.Mesnard and D.Vasilescu.
C.R. Acad. Sci. (France), Vol. 251, No. 5, 660-1 (Aug. 1, 1960).
In French.

The observed variations in the dielectric constant and loss angle in ceramic disks of $BaTiO_3$ are qualitatively explained in terms of the effects of electromechanical resonance, dielectric relaxation and electric hysteresis. L.E.Cross

1133 DIELECTRIC CONSTANT AND DIELECTRIC LOSS OF TiO_2 (RUTILE) AT LOW FREQUENCIES.

R.A.Parker and J.H.Wasilik.
Phys. Rev. (USA), Vol. 120, No. 5, 1631-7 (Dec. 1, 1960).

Measurements were made of the complex capacitance ($C=C'-iC''$) of undoped, high-resistance, single-crystal TiO_2 (rutile) in vacuum at 78, 195, 273, and 300°K as a function of frequency between 10^1 and 3 × 10^6 c/s with a 0.1 V a.c. signal. With the field in the c direction, one low-frequency loss peak is found at 200 c/s. The capacitance C' and loss C'' of a 2 mm cube with the field in the c direction are characterized by $1/2\pi\tau = 200$ sec^{-1} tan δ (200) c/s = 0.7, and a dielectric constant ϵ'(1 Mc/s) of 170, while ϵ'(20 c/s) = 30 000. The loss and low frequency capacitance of the crystal are directly proportional to the area of the electrodes and depend but slightly on the sample thickness, electrode materials and surface treatment. C' and C'' were measured at 300°K as a function of the oxygen vacancy concentration in the crystal. C' and C'' were also measured as a function of d.c. bias from 0 to 400 V; C'(200 c/s), C''(max) and τ are proportional to V^{-n} where n is between 0.3 and

0.8. The results of the experiments can be explained by an electron-deficient barrier layer whose thickness increases with increasing applied d.c. voltage. When the d.c. voltage in the c direction is changed, effects are observed whose time constants are of the order of hours or even days.

1134 ON THE PHASE TRANSITIONS OF BARIUM TITANATE CRYSTALS. W.Kinase.
Progr. theor. Phys. (Japan), Vol. 22, No. 5, 736-8 (Nov. 1959).

Extending the methods of Devonshire and Slater, the variations in the ionic arrangement in $BaTiO_3$, due to a field applied perpendicular to the direction of the spontaneous polarization, are examined. The titanium ion displacements, spontaneous polarization, and clamped dielectric constant ϵ are calculated for both the cubic and tetragonal phases. L.E.Cross

1135 DIELECTRIC PROPERTY OF TRIGLYCINE SULFATE SINGLE CRYSTAL AT 9000 Mc/s REGION.
A.Nishioka and M.Takeuchi.
J. Phys. Soc. Japan, Vol. 14, No. 7, 971 (July, 1959).

The permittivity and loss angle were measured by a standing-wave method at 9600 Mc/s and room temperature. The values of $\epsilon_b = 19.7$ and $\tan \delta = 0.043$ suggest that some dielectric relaxation had occurred. Qualitative measurements of ϵ_b as a function of temperature in the 9 kMc/s range, however, still show a marked peak at the Curie temperature. L.E.Cross

1136 FERROELECTRICITY IN POTASSIUM FERROCYANIDE TRIHYDRATE.
S.Waku, H.Hirabayashi, H.Toyoda, H.Iwasaki and R.Kiriyama.
J. Phys. Soc. Japan, Vol. 14, No. 7, 973-4 (July, 1959).

$K_4[Fe(CN)_6].3H_2O$ is ferroelectric below -22^0C. At room temperature the symmetry is monoclinic, space group C 2/2, with the cell constants $a = 9.32$, $b = 16.84$, $c = 9.32$A; $\beta = 90^0 \pm 5'$. Dielectric measurements show electric hysteresis below -22^0C for fields applied along [101] and $[10\bar{1}]$; at -50^0C the spontaneous polarization is approximately 0.4 μC cm^{-2} and E_C 15kV/cm. There are five peaks in the permittivity—temperature curves at −22, −26, −33, −43 and -80^0C. L.E.Cross

1137 FERROELECTRIC PROPERTIES OF $BaLi_{2x}Al_{2-2x}F_{4x}O_{4-4x}$. T.G.Dunne and N.R.Stemple.
Phys. Rev. (USA), Vcl. 120, No. 6, 1949-50 (Dec. 15, 1960).

Single crystals with x = 0.15 to 0.30 were found to be ferroelectric with a Curie temperature in the range $127\text{-}153^0$C and a room-temperature spontaneous polarization along the hexagonal c-axis of approximately 0.1 μcoul/cm^2. The structure of these mixed crystals is unrelated to that of any previously known ferroelectric, but appears to be very similar to that of $BaAl_2O_4$.

1138 CHANGE OF DIELECTRIC PROPERTIES OF RUTILE CERAMICS WITH THE PASSAGE OF A CURRENT AND WITH HEATING. V.Ya.Kunin and A.A.Tsikin.
Fiz. tverdogo Tela (USSR), Vol. 2, No. 10, 2359-65 (Oct., 1960).
In Russian.

The increase in current through a rutile ceramic with time is determined at 150^0C for a series of voltage gradients ranging from 250 to 2500 V/mm. The effect of voltage gradient and temperature on the lifetime of the ceramic, and the change in carrier current activation energy with sustained exposure to a voltage gradient are also determined. Other points investigated include the effect of periodically reversing the current polarity, and of oxidizing and reducing the TiO_2. It is concluded that the changes in the ceramic are due to an ageing process connecting with the formation of anionic vacancies in TiO_2. [English translation in: Soviet Physics—Solid State (USA)]. R.F.S.Hearmon

1139 FERRIELECTRICITY.
C.F.Pulvari.
Phys. Rev. (USA), Vol. 120, No. 5, 1670-3 (Dec. 1, 1960).

A new group of materials has been found exhibiting ferroelectric behaviour. This behaviour appears in a mixture of antiferroelectric compounds (sodium vanadate and sodium niobate; also sodium niobate and silver niobate) neither of which exhibits this phenomenon at low field strength in their pure states. Coercivity as well as polarization is composition dependent. The onset of the ferroelectric state is a function of applied field, which in some compositions is considerably higher than the coercive field. Switching transients of a form not previously reported are exhibited by these materials.

539.2 : 537.

1140 HIGH-TEMPERATURE DIELECTRIC BREAKDOWN OF ALKALI HALIDES. J.J.O'Dwyer.
Austral. J. Phys., Vol. 13, No. 2a, 270-7 (July, 1960).

Solid State Physics Conference (see Abstr. 17864 of 1960). In the high-temperature region much of the experimental work on the dielectric breakdown of the alkali halides is apparently conflicting. If, however, it is assumed that breakdown is thermal in natur instead of intrinsic, reasons can be given which reduce the differenc between various sets of existing experimental results. A calculatio of the thermal breakdown strength is given based on the assumption that the electrical conductivity is principally ionic. The magnitude and temperature variation of the breakdown strength is given correc ly without disposable constants. Some suggestions are given for experimental work which may clear up outstanding difficulties.

1141 HIGH-TEMPERATURE DISCHARGES IN FERROELECTRIC CERAMICS. J.W.Northrip.
J. appl. Phys. (USA), Vol. 31, No. 12, 2293-6 (Dec., 1960).

Ceramic disks of barium titanate and lead zirconate titanate, when heated above 100^0C, exhibit current discharges which cannot be attributed to the ferroelectric polarization of the material. Thes discharges are largest in the temperature interval $300^0\text{-}600^0$C and depend primarily on the electrode material and its method of application. Discharges of several millicoulombs at voltages up to one-half volt have been obtained from a ceramic disk one-half inch in diameter and 30 mils thick having a silver electrode and an indium counterelectrode. Although thermoelectric, pyroelectric, and electret effects are observed in these samples, these phenomen contribute only a very small portion of the total discharge. At constant temperature near 350^0C the discharge decays with time as the sum of two exponentials, falling to half-maximum in periods of the order of one-half hour. At higher temperatures the decay rate increases, while temperature cycling produces a voltage cycling superimposed on the decay. These findings support an explanation of the effect in terms of solid state chemical activity between the metallic electrodes and the titanate lattice.

OPTICAL PROPERTIES OF SOLIDS

(Including X-ray Spectra)

1142 ON THE OPTICAL AND ELECTRICAL PROPERTIES O SEMITRANSPARENT COPPER FILMS. R.S.Adhav.
Canad. J. Phys., Vol. 38, No. 12, 1570-6 (Dec., 1960).

Simultaneous measurements were made of the optical constant n and k, reflectance R, transmittance T, and of the d.c. conductivit σ, of semitransparent copper films deposited onto quartz by evaporation in vacuo. All depositions were carried out at a pressure $p = 10^{-5}$ mm Hg and with a deposition rate D = 2 A/sec. The optica constants were determined by an ellipsometer with a photomultipli tube attachment at the wavelengths 435 mμ, 546 mμ, and 630 mμ. The reflectance values were computed from the optical constants. The transmittance values were measured at these wavelengths by a Unicam spectrophotometer. The d.c. conductivities were measure by a Kohlrausch bridge. These measurements were carried out in the thickness range 60 A to 455 A. The disagreement of the result with the Garnett theory and the Fuchs theory is discussed and conclusions regarding the structure and the degree of porosity are drawn.

1143 OPTICAL INVESTIGATION OF THE BAND STRUCTURE OF GaSb. M.Cardona.
Z. Phys. (Germany), Vol. 161, No. 1, 99-102 (1960).

The reflectivity was measured for photon energies between 0.5 and 5 eV. A structure similar to the one observed for the reflectivity of Ge was seen. Reflectivity maxima occur at 1.95, 2.47 and 4.3 eV, which can be associated with the same mechanisms producing a similar structure in Ge. Thus, further evidence of the close similarity of the band structures of Ge and GaSb has been obtained.

1144 DISPERSION OF BIREFRINGENCE OF PHENACITE IN THE INFRARED.

M.Vergnoux, J.C.Bourguet and J L.Fagegaltier.
R. Acad. Sci. (France), Vol. 251, No. 5, 689-90 (Aug. 1, 1960).
French.

The method of channelled spectra was used to measure the
spersion of the birefringence over the range 0.5 to 4.3 μ. The
refringence varied from 0.0157 to 0.0125. A curve of the bire-
ngence against wavelength was plotted and it showed a number of
omalies. The latter were related to absorption anisotropies.

H.G.Jerrard

1145 ON THE THEORY OF THE OPTICAL FARADAY EFFECT IN FERRIMAGNETIC SINGLE CRYSTALS OF GARNET
A RADIOFREQUENCY FIELD. G.V.Skrotskii and T.G.Izyumova.
z. tverdogo Tela (USSR), Vol. 2, No. 10, 2458-60 (Oct., 1960).
Russian.

It is shown that the specific rotation of the plane of polarization
visible light traversing a slice of a single crystal of a rare-earth
rnet, in the presence of a radiofrequency field adjusted to ferri-
gnetic resonance is

$$\theta = (2\pi\gamma n M_S/c)(1-h_0^2/\alpha^2 H_0^2)^{1/2}.$$

is suggests a method of rapid modulation of a beam of light, using
.f. field of very low power. When dealing with thin plates of
ystal, as in Dillon's work, the demagnetizing field must be taken
o account by replacing $H_0 - 4\pi M_Z$. A set of graphs shows the
ation between θ and M_Z in this case. Experiment reveals some
explained anomalies in the appearance of supplementary maxima
the values of θ. Experiments analogous to those of Daniels and
semeyer, but carried out on rare-earth garnets, will serve to
rify or disprove the conclusions of this paper. See Abstr. 2264,
95 of 1958; 11231, 12157 of 1959. [English translation in: Soviet
ysics — Solid State (USA)].

N.Davy

1146 INFRARED FARADAY ROTATION AND FREE CARRIER ABSORPTION IN Bi_2Te_3. I.G.Austin.

oc. Phys. Soc. (GB), Vol. 76, Pt 2, 169-9 (Aug., 1960).

The Faraday rotation at wavelengths in the range 8-15 μ was
asured on several n- and p-type single crystals of Bi_2Te_3 using a
gnetic field of 17 kOe. The results are interpreted as the sum of
ations arising from free carriers and interband transitions. The
er appear to be sensitive to the impurity content. An attempt
s made to separate the components and use the free-carrier ro-
on to estimate the effective-mass parameters. Free-carrier
orption measurements in the range 8-20 μ are also reported.
se led to an independent estimate of the same effective-mass
ameters, showing fair agreement with the Faraday measurements.
results are discussed in the light of recent galvanomagnetic
asurements on some of the crystals.

1147 FAR INFRARED STUDIES OF BISMUTH.

W.S.Boyle and A.D.Brailsford.
ys. Rev. (USA), Vol. 120, No. 6, 1943-9 (Dec. 15, 1960).

Reports zero-field and magneto-optic studies covering a range
frequencies where the plasma effects are large and rapidly
nging. It is found that the data lend themselves to an interpre-
on in terms of classical magneto-plasma theory when anisotropy
aken into account. The contribution of the free carriers to the
ical properties can be isolated from the interband transitions and
ce the static value of the dielectric constant, ϵ_0, the number of
e electrons per cm^3, n, and the effective-mass parameters for
electron band can be determined when used in conjunction with
results of cyclotron resonance studies.

1148 LINE SHAPES OF INTERBAND MAGNETO-OPTICAL ABSORPTION IN THE SEMICONDUCTORS.

hta and T.Miyakawa.
gr. theor Phys. (Japan), Vol. 22, No. 6, 893-5 (Dec., 1959).

The shape is calculated under the assumption of parabolic
ds, treating the interaction with the phonons by means of the
hod originally devised by Toyozawa (Abstr. 7504 of 1959) for
tons. The order of magnitude of the parameters determining
absorption peaks is evaluated in the two limiting cases of strong
weak applied magnetic field.

L.Pincherle

1149 MICROWAVE MODULATION OF LIGHT IN PARAMAGNETIC CRYSTALS.

loembergen, P.S.Pershan and L.R.Wilcox.
s. Rev. (USA), Vol. 120, No. 6, 2014-23 (Dec. 15, 1960).

The considerations of Dehmelt (Abstr. 7317 of 1957) and several other workers about the modulation of light by radiofrequency signals in atomic vapours are extended to paramagnetic solids. It is shown that these materials, driven near a microwave resonance at low temperatures, may be used both to create and to detect modulation of light at microwave frequencies. Experimental design criteria are discussed in the light of two numerical examples, modulated circular dichroism in ruby and modulated Faraday rotation in a broad class of ionic rare earth compounds. Some possible applications of microwave modulated light are reviewed.

1150 A PROPOSED MODEL FOR THE EXPLANATION OF THE URBACH RULE. Y.Toyozawa.

Progr. theor. Phys. (Japan), Vol. 22, No. 3, 455-7 (Sept., 1959).

A formula for the optical absorption coefficient of ionic crystals is derived assuming that the deformation potential caused by local dilatations of the lattice contains both linear and quadratic terms in the dilatation. It is also necessary to assume that the mode of lattice vibration responsible for the tail of the spectrum differs from that contributing to the central part of the spectrum. With these assumptions it is possible to fit the experimental absorption coefficient over the whole frequency range.

K.G.Major

1151 SOME OPTICAL PROPERTIES OF CdSe SINGLE CRYSTALS. S.P.Keller and G.D.Pettit.

Phys. Rev. (USA), Vol. 120, No. 6, 1974-7 (Dec. 15, 1960).

Optical transmission and reflection measurements were made on a single crystal of CdSe (crystal class C_{6v}) with light polarized parallel and perpendicular to the c-axis. The absorption coefficients $\mu_\perp$ and $\mu_\parallel$, were determined and are presented as functions of incident photon energy, at room temperature. The selection rule, $\mu_\perp > \mu_\parallel$, expected for all solids in the crystal classes C_{nv} and C_n, where n = 3, 4, or 6, is very well obeyed in CdSe. The absorption coefficients are not simple functions of the photon energy, but are nearly exponential and almost follow Urbach's rule. The fluorescence of the single crystal was measured at 77° K. It is peaked at 920 mμ and it is slightly polarized perpendicular to the c-axis. The results are similar to what has been obtained for hexagonal ZnS.

1152 INFRARED ABSORPTION IN N-TYPE SILICON.

V.A.Yakovlev.
Fiz. tverdogo Tela (USSR), Vol. 2, No. 10, 2639-40 (Oct., 1960). In Russian.

Vavilov (Abstr. 16071 of 1960) reported that in the range 2-7 μ, the absorption coefficient of n-type silicon was greater than that predicted theoretically. It is shown here that this anomaly is due to the optical mode of the silicon lattice vibrations. [English translation in: Soviet Physics—Solid State (USA)].

A.Tybulewicz

1153 THE EFFECT OF A STRONG ELECTRIC FIELD ON ABSORPTION OF LIGHT BY SILICON.

V.S.Vavilov and K.I.Britsўn.
Fiz. tverdogo Tela (USSR), Vol. 2, No. 8, 1937-9 (Aug., 1960). In Russian.

Neutron-irradiated silicon monocrystals of 10^{11} ohm cm resistivity were illuminated at 100° K with monochromatic light of wavelengths ranging from 0.75 to 1.15 μ. Fields of the order of 10 000 V/cm produced a considerable shift of the band edge (in the region of valence—conduction band transitions with phonon participation) and considerably increased the absorption coefficient. [English translation in: Soviet Physics —Solid State (USA)].

A.Tybulewicz

1154 ABSORPTION OF LIGHT AND LUMINESCENCE OF M-CENTRES IN THE MACROSCOPIC APPROXIMATION.

V.L.Vinetskii.
Optika i Spektrosk. (USSR), Vol. 9, No. 1, 64-9 (July, 1960). In Russian.

Reports a calculation of the absorption and luminescence parameters of an M-centre, using Seitz's model in the macroscopic approximation. The results for a KCl crystal did not agree with the experimental value of the M-band maximum (1.5 eV); the reasons for this discrepancy are discussed. [English translation in: Optics and Spectrosc. (USA)].

A.Tybulewicz

1155 ELECTRONIC ABSORPTION SPECTRA OF MOLECULAR CRYSTALS. J.Tanaka.

Suppl. Progr. theor. Phys. (Japan), No. 12, 183-210 (1959).

Electronic absorption spectra of aromatic molecular crystals are reviewed from the theoretical and experimental points of view. The molecular exciton theory proposed by Davydov (1948) is described with some examples. A theory of electron transfer in molecular crystal is discussed in connection with the mechanism of photoconduction, and other theories relevant to optical properties of insulating crystals are briefly surveyed. Experimental results on the electronic absorption spectra of molecular crystals are presented, the molecules being classified as follows: benzene and its derivatives, catacondensed aromatic hydrocarbons, and other miscellaneous molecules. It is emphasized that the measurements of the spectra of molecular crystals give valuable information on the excited states of these molecules as well as on the behaviour of excitons in these crystals.

1156 BAND STRUCTURE OF NOBLE METAL ALLOYS: OPTICAL ABSORPTION IN Cu–Ge ALLOYS AT 4.2°K.

J.A.Rayne.
Phys. Rev. (USA), Vol. 121, No. 2, 456-61 (Jan. 15, 1961).

For previous work, see Abstr. 1542 of 1960. Calorimetric optical absorption measurements at 4.2°K were made on a representative series of Cu–Ge alloys, over the wavelength range 0.23 to 4 μs, using electropolished bulk specimens. The variation of the infrared absorptivity with residual resistance for the dilute alloys confirms that the impurity relaxation time for copper is anisotropic. Changes in the absorption spectrum below 6000 A are inconsistent with the rigid band model, but may be reconciled with the theory of Cohen and Heine (1954). The shift in the main absorption edge is analysed to give information about the screening of the solute atoms in these alloys.

1157 ABSORPTION SPECTRA OF CUPROUS OXIDE.

M.Hayashi.
Suppl. Progr. theor. Phys (Japan), No. 12, 160-73 (1959).

A brief description is given of the procedure of preparing Cu_2O and of the results of a study of its absorption spectra. With Cu_2O irradiated with gamma rays, a sharp absorption line was found at low temperatures. This line coincides with that discovered by Gross [Nuovo Cimento Suppl., Vol. 3, 672 (1956)], who interpreted it as the first member of the hydrogen-like absorption lines in the yellow region. A discussion on this absorption line is given.

1158 NUCLEAR HYPERFINE STRUCTURE IN THE ABSORPTION SPECTRUM OF A CRYSTALLINE SALT.

I.Grohmann, K.H.Hellwege and H.G.Kahle.
Naturwissenschaften (Germany), Vol. 47, No. 12, 277-8 (1960).
In German.

Reports the successful resolution into eight components of some Ho^{3+} ion optical transitions in crystalline $Ho(C_2H_5SO_4)\cdot 9H_2O$ at 4.2°K with magnetic fields of the order of 28 000 kOe applied parallel to the crystalline z-axis. The eight components are ascribed to the hyperfine interaction of Ho^{165} ($I = 7/2$). Analysis is performed on the basis of the usual spin Hamiltonian. P.M.Parker

1159 LATTICE ABSORPTION BANDS IN INDIUM ANTIMONIDE.

S.J.Fray, F.A.Johnson and R.H.Jones.
Proc. Phys. Soc. (GB), Vol. 76, Pt 6, 939-48 (Dec. 1, 1960).

A series of detailed measurements of the absorption spectrum of high-quality single crystals of n-type indium antimonide was made in the wavelength range 15 to 130 μ, and over the temperature range 4.2 to 90°K. Some new absorption bands were found, and an explanation is offered for the positions and temperature dependence of all the principal absorption peaks in terms of multiple phonon interactions involving phonons with energies corresponding to temperatures of 259, 224, 169 and 62°K.

1160 SOME NEW OBSERVATIONS ABOUT THE ABSORPTION SPECTRA, REFLECTION AND PHOTOLUMINESCENCE OF PbI_2 MONOCRYSTALS AT 4°K.

S.Nikitine, J.Burckel, J.Biellmann and R.Reiss.
C.R. Acad. Sci. (France), Vol. 251, No. 7, 935-7 (Aug. 17, 1960).
In French.

Thin single crystals (of thicknesses from 0.04 to 0.4 μ) prepared by evaporation of a solution were examined. Several narrow absorption bands were found corresponding to selective reflections. New photoluminescent bands were observed. A reflection minimum is explained as being due to a negative dispersion, and a fine structure in one strong absorption band is similarly explained. C.A.Hogarth

1161 PRELIMINARY STUDY OF THE EXCITON ABSORPTION SPECTRUM OF PbI_2.

I.Imai and K.Ishiguro.
Suppl. Progr. theor Phys. (Japan), No 12, 174-82 (1959).

The absorption spectra of PbI_2 at low temperatures were examined using Nikitine's method (Abstr. 16048 of 1960). For the 500 mμ band, the existence of the hydrogen-like series was confirmed under the assumption that the band was composed of several components of Gaussian type, represented by the formula (at 20° K) $\nu = 20\,853 - 1150/n^2$ cm^{-1}. As for the shape of each component of the band, the Gaussian form was preferable than the Lorentzian one, though the latter was expected from Toyozawa's theory (1957) From the temperature dependence of the band, it wa concluded that (1) the rate of shift of the absorption maximum towards the shorter wavelength with the lowering of temperature is about 1.5×10^{-4} eV/°K and (2) the half-value width of the band is about 0.02 eV, which is not sensitive to temperature.

1162 THE OPTICAL ABSORPTION IN MANGANESE ZINC FLUORIDE SINGLE CRYSTALS NEAR THE NÉEL TEMPERATURE.

D.M.Finlayson, I.S.Robertson, T.Smith and R.W.H.Stevenson.
Proc. Phys. Soc. (GB), Vol. 76, Pt 3, 355-68 (Sept. 1, 1960).

The visible and ultraviolet absorption spectra of single crystal of manganese fluoride, and of two manganese–zinc fluoride mixtures, were measured down to 62° K. The sharp lines arising from the level complexes $\{{}^4E_g{}^4A_{1g}\}({}^4G)$ and ${}^4E_g({}^4D)$, which were insensitive to the magnitude of the crystalline electrostatic field, showed a non-linear shift with temperature, which varied with composition, and was correlated with the temperatures at which long-range antiferromagnetic order became appreciable. A separation of the exchange interaction effect from that due to the thermal expansion of the lattice could be made with some certainty in the material of medium dilution, except in the immediate neighbourhood of the ordering temperature where effects due to the lattice expansion anomaly might be appreciable. The magnitude of the antiferromagnetic interaction shift aided the identification of the transitions, and was interpreted as giving a measure of the variation of short-range spin order with temperature. Measurements of line width an oscillator strength were made for several absorption lines, and the data for the magnetically dilute materials could be interpreted on simple vibrational models, but for pure manganese fluoride these models seemed less satisfactory.

1163 INFRARED SPECTRUM OF PRASEODYMIUM NITRIT

F.Vratny, M.Tsai and F.Gugliotta.
Nature (GB), Vol. 188, 484-5 (Nov. 5, 1960).

Spectra obtained by dispersing powdered nitrite in either Nujol or KCl pellets indicate that the nitrite group forms a bridge structure with praseodymium, having two main vibration modes at 6.8 and 8.3 μ. This bridge formation explains the difference betwe spectra of praseodymium nitrite and the simple metallic nitrites (e.g. sodium, potassium and silver). D.L.Greenawa

1164 SPECTRUM AND ZEEMAN EFFECT OF TRIVALENT PRASEODYMIUM IN HEXAGONAL ETHYLSULPHATE

K.H.Hellwege, G.Hess and H.G.Kahle.
Z. Phys. (Germany), Vol. 159, No. 3, 333-47 (1960). In German.

The spectra of single crystals strongly diluted with Ce salt (Ce:Pr ≥ 25 : 1) are photographed at 4.2° K in the visible. A term scheme for the observed lines is given. The splitting indicates a crystal field of symmetry D_{3h}. Values of crystal quantum number crystal field matrix elements and g-factors are determined. G.F.Loth

1165 SPECTRUM, ZEEMAN EFFECT AND ELECTRON TERMS OF TRIVALENT ERBIUM IN CRYSTALLINE SALTS. I. ERBIUM ETHYLSULPHATE, $Er(C_2H_5SO_4)_3.9H_2O$. II. ERBIUM CHLORIDE, $ErCl_3.6H_2O$ AND ERBIUM NITRATE, $Er(NO_3)_3.6H_2O$.

K.H.Hellwege, S.Hüfner and H.G.Kahle.
Z. Phys. (Germany), Vol. 160, No. 2, 149-61, 162-70 (1960).
In German.

Spectra and Zeeman patterns in the visible are photographed temperatures of liquid He and liquid air for single crystals, alone and diluted in isomorphous yttrium crystals. J values and Landé g-factors are determined. The ethylsulphate has symmetry D_{3h}. G.F.Loth

1166 ABSORPTION SPECTRA OF DEFECTS IN IONIC LATTICES.

O.Stasiv.
Izv. Akad. Nauk SSSR Ser. fiz. (USSR), Vol. 24, No. 2, 220-3; Disc. 242-5 (1960). In Russian.

"1958 Moscow Dielectrics Conference." (see Abstr. 16003 of 19 The peaks in the absorption spectra of silver bromide due to various divalent impurities were examined. The positions of thes are found to satisfy a relation developed by Koswig (Abstr. 4875

8). The results are thought to support the Koswig formula necting the absorption spectra of colour centres and divalent ons, at least for the case of silver halides. K.N.R.Taylor

1167 THE INFRARED SPECTRA OF CRYSTALS.
B.Szigeti.

oc. Roy. Soc. A (GB), Vol. 258, 377-401 (Oct. 25, 1960).

The higher-order effects in the intrinsic infrared absorption crystals are investigated in a systematic way. In agreement h a previous paper which dealt with the static dielectric constant, s found that in the case of ionic crystals the third-and fourth-ler potential, the second-and the third-order dipole moment, and cross-terms between the second-order moment and the third-ler potential all contribute terms of the same order to the rared spectrum. In the lowest approximation, the third-order ment and the fourth-order potential only affect the absorption in immediate neighbourhood of the maximum and hence have little ect on the shape of the spectrum. The broadening of the main d is due mainly to the third-order potential, while the side bands y be caused by the second-order moment as well as by the third-ler potential and by cross-terms between the two. But due to an ernal field effect, in strongly ionic crystals a large second-order ment automatically leads to a large third-order potential: thus a ge second-order moment may increase the width of the main band well as the intensity of the side bands. Although the intrinsic rared absorption of valency crystals, such as diamond or germa-m, is due to the second-order moment only, nevertheless, there strong similarity between the expressions for the infrared orption of valency crystals and for the side-band absorption of ic crystals. This similarity suggests that the spectra of all ionic stals should exhibit a number of secondary maxima. The ilable experimental evidence does not seem sufficient to decide ether this suggestion is correct.

1168 THE INFRARED DISPERSION OF ALKALI HALIDES. I. THE INTERPRETATION OF THE SPECTRA CORDING TO THE BORN—HUANG THEORY.
Bilz, L.Genzel and H.Happp.

Phys. (Germany), Vol. 160, No. 5, 535-53 (1960). In German.

The infrared spectra of LiF, NaCl and CsBr are interpreted cording to the dispersion theory of Born and Huang (1954). This ory takes into account anharmonic terms in the lattice potential leads to a frequency-dependent damping which describes the sorption. This damping function is first obtained by evaluating empirical data of the optical constants and is then compared h an approximate computation based on the frequency spectrum lattice vibrations. The result of this comparison shows that ory and experiment correspond qualitatively very closely, ecially with respect to the secondary structure in dispersion.

1169 SOME COMMENTS ON THE INFRARED SPECTRA OF DIAMOND, SILICON, AND GERMANIUM.
.B.M.Sutherland.

Opt. Soc. Amer., Vol. 50, No. 12, 1201-3 (Dec., 1960).

Some problems connected with the interpretation of the infrared ctra of diamond, silicon, and germanium are re-examined.

1170 THE INFRARED SPECTRUM AT LARGE DISPERSION OF THREE TYPES OF DIAMOND AND ITS VARIATIONS A FUNCTION OF THE TEMPERATURE.
J.J.Charette.

ysica (Netherlands), Vol. 25, No. 12, 1303-12 (Dec., 1959). French.

The infrared spectra of two type I, one type IIa and one type diamonds were obtained between 500 and 11500 cm^{-1}, the same cimen having been examined at two different thicknesses. The ting spectrograph permitted the use of spectral slit widths row enough to observe the true width of most of the bands, to find wave numbers with a precision better than 0.1 cm^{-1} and to attain esolving power of 0.5 cm^{-1}. A systematic study of the variation he infrared spectra with temperature showed three distinct beha-urs of the bands. A group underwent absolutely no change between K and 420^{0}K. The bands common to the three types showed slight rease of the absorption coefficient, with increasing temperature, ounting to 0.009 cm^{-1} per degree. The bands characteristic of IIb diamond manifested an increase of the absorption coefficient decreasing temperature: 0.038 cm^{-1} per degree for the 6 cm^{-1} band and 0.013 cm^{-1}per degree for the others. At the same e, the integrated surface of the absorption bands increased with reasing temperature while the half width of the bands decreased. lly a shift of frequency of 0.008 to 0.016 cm^{-1} per degree took e towards higher frequencies with increasing temperature.

1171 THE RAMAN AND INFRA-RED SPECTRA OF SOME SOLID HYDROXIDES. I. RAMAN EFFECT DATA. II. CORRELATION WITH CRYSTAL STRUCTURE. III. DISCUSSION OF THE INFRA-RED DATA.
D.Krishnamurti.

Proc. Indian Acad. Sci. A, Vol. 50, No. 4, 223-31, 232-46, 247-53 (Oct., 1959).

Reports studies of the hydroxides of Li, Na and K and their monohydrates, the hydroxodes of Ca, Mg and Al, and the octahydrated hydroxides of Ba and Sr. The results are interpreted in terms of crystal structure. G.I.W.Llewelyn

1172 RAMAN SPECTRA OF MIXED CRYSTALS OF ALKALI HALIDES.
A.I.Stekhanov and M.B.Éliashberg.

Fiz. tverdogo Tela (USSR), Vol. 2, No. 10, 2354-5 (Oct., 1960). In Russian.

Second-order spectra of KBr and of mixed KBr—KCl (80/20, 40/60 and 20/80%) crystals are continuous spectra with intensity maxima, the spectra of mixed crystals preserving some features of KBr spectra even when the proportion of KCl is 80%. The rise of temperature has little effect on the intensity distribution in the spectra of mixed crystals. Some conclusions are drawn with respect to the properties of elastic spectra of these crystals. [English translation in: Soviet Physics—Solid State (USA)]. F.Lachman

1173 VALENCE BAND EMISSION SPECTRA OF IRON, COBALT, AND NICKEL.
D.H.Tomboulian and D.E.Bedo.

Phys. Rev. (USA), Vol. 121, No. 1, 146-52 (Jan. 1, 1961).

For previous work (on Cu), see Abstr. 4665 of 1959. Presents results on the shapes of the $M_{2,3}$ emission bands (valence → 3p) of Fe, Co, and Ni. The relative intensity distributions were arrived at by removing the underlying background contribution in accordance with the predictions made available from recent investigations dealing with the behaviour of the soft X-ray bremsstrahlung intensity. In the spectrum of Fe, the peak of the composite $M_{2,3}$ band falls at 51.3 eV. The peaks in the Co and Ni spectra are located at 57.8 and 64.8 eV, respectively. The high-energy limits are estimated to fall at 56.5, 61.4, and 68.9 eV for Fe, Co, and Ni, respectively. The over-all composite bandwidths in eV in the order of metals just cited are found to be: 14.5, 10.8, and 9.3. These estimates include the low-energy tail belonging to the individual M_3 spectral bands. An attempt was made to resolve the Fe $M_{2,3}$ complex band into individual M_2 and M_3 bands. In this process the inner levels were regarded as sharp, but the influence of Auger reorganization upon the relative band intensities was taken into account. For Fe, this process gives an individual bandwidth of 8.0 eV. The results of the present observations are compared with other determinations of band contours. The various measurements are in agreement as to the location of the peak energy but there are differences in the intensity profiles and bandwidths.

1174 THE SOFT X-RAY SPECTRA OF LITHIUM, MAGNESIUM AND ALUMINIUM AND THEIR ALLOYS.
R.S.Crisp and S.E.Williams.

Phil. Mag. (Eighth Ser.)(GB), Vol. 5, 1205-16 (Dec., 1960).

The Li K and Mg L_{23} spectra were observed from a range of Li—Mg alloys, evidence for electron transfer from Mg being obtained. More distinct changes were observed for the same spectra when Li was evaporated onto solid Mg and Mg onto solid Li. Changes in the Li K and Al L_{23} were observed when Li was evaporated onto Al and in the Al L_{23} when Al was evaporated onto Mg. No changes greater than 5 × 10^{-2} eV were observed in edge wavelengths or edge widths although marked depopulation of higher energy states occurred in Mg and Al. It was inferred that changes in the screening of K and L levels compensated almost exactly for the effects of electron transfer. The results of Catterall and Trotter (1959) were confirmed in that the Mg band contracted and Li band extended on the low-energy side. Li deposited on Al showed a K spectrum without any metal edge, suggesting that the first zone was filled and that there was no overlap with the second zone.

Luminescence

1175 LUMINESCENCE OF LOCALIZED EXCITONS AND EXCITON INDUCED LUMINESCENCE IN ALKALI HALIDES.
M.Tomura and Y.Kaifu.

Suppl. Progr. theor. Phys. (Japan), No. 12, 141-59 (1959).

Two experiments were carried out with KI. Luminescence from localized I$^-$ ions in KBr—KI mixed crystals were measured. The emission suffered from Stokes shift and was observed even in the case of a KI concentration of 8.5 × 10^{-1} mol. Energies of localized excitons around I$^-$ ions are transferred to some impurities in cases of high concentrations of I$^-$ ions. Next, exciton-induced luminescence from Tl$^+$ ions in KI—TlI is discussed. The yield is almost independent of the concentration of Tl$^+$ ions, which suggests the migration of excitons in KI. The induced luminescence shows temperature dependence. The characteristics of the exciton are discussed on the basis of these results.

1176 ENERGY MODEL FOR EDGE EMISSION IN CADMIUM SULFIDE.

L.S.Pedrotti and D.C.Reynolds.
Phys. Rev. (USA), Vol. 120, No. 5, 1664-9 (Dec. 1, 1960).

The blue and green fluorescence emitted by CdS single crystals subjected to ultraviolet radiation at low temperatures was examined in the temperature interval from 4.2° to 77° K. The spectral position and relative intensity of certain lines found in this fluorescence were measured as a function of temperature over this range. The degree of polarization of the fluorescence was investigated at 4.2° K. From this data an energy model is proposed which accounts for the transitions leading to the blue and green fluorescence at 4.2° K, the change in these transitions as the temperature increases from 4.2° to 77° K, and the transitions leading to the blue and green fluorescence at 77° K.

1177 EFFECT OF ALUMINIUM ON THE GREEN EMISSION OF CADMIUM SULPHIDE.

M.Avinor.
Physica (Netherlands), Vol. 25, No. 11, 1095-6 (Nov., 1959).

It is suggested that the 2.4 eV emission in CdS excited at low temperature may be due to the presence of trace amounts of Al. The author found that the emission could be enhanced by the deliberate addition of 4 × 10^{-4} atom/mole of Al, but this destroyed the fine structure. Stronger interaction between the centres at higher concentrations may be responsible for the loss of structure. The additional Al also enhanced a weaker line at 900 mμ. I.Cooke

1178 HIGH TEMPERATURE PHOSPHORESCENCE IN CORONENE.

M.Zander.
Naturwissenschaften (Germany), Vol. 47, No. 19, 443 (1960).
In German.

Excited by ultraviolet, a solid solution of 2% coronene in perhydrocoronene shows yellow phosphorescence at -196° C and at room temperature. This is the transition from excited triplet state to singlet state. At 100° a strong blue phosphorescence is also seen in the solid solution and this alone remains at 170°, when apart from temperature broadening of the bands the spectrum is the same as that of low temperature fluorescence of coronene in hexane. At the higher temperatures a transition occurs from the first excited triplet state to the higher first excited singlet state, followed by a transition to the ground state with fluorescence. The energy required for the first (radiationless) transition is ~12 kcal/mole, a value similar to that for organic dyes showing high temperature phosphorescence, whereas other polycyclic hydrocarbons have larger energy differences between the states concerned and do not show the effect. There is no explanation why the blue phosphorescence is still weakly seen at -196°. S.T.Henderson

1179 FLUORESCENCE YIELD OF EOSIN SOLUTIONS IN COLLODION AND IN GLUCOSE.

R.Drabent.
Bull. Acad. Polon. Sci. Ser. Sci. math. astron. phys. (Poland), Vol. 8, No. 6, 403-6 (1960).

Curves are given showing the fluorescence yield over a range of wavelengths. For eosin in collodion the yield is at a maximum over the range 5450 to 5700 A, with a sharp decrease at longer wavelengths. For the glucose solution a similar maximum efficiency is found between 5300 and 5500 A, with an even steeper decrease. There is no clear relation between these curves, the absorption spectra of the two solutions, and their emission maxima.
S.T.Henderson

1180 ZEEMAN EFFECT OF THE PURELY CUBIC FIELD FLUORESCENCE LINE OF MgO:Cr^{3+} CRYSTALS.

S.Sugano, A.L.Schawlow and F.Varsanyi.
Phys. Rev. (USA), Vol. 120, No. 6, 2045-53 (Dec. 15, 1960).

Both transverse and longitudinal Zeeman effects were studied for the most conspicuous red emission line (14 319 cm^{-1}) of a MgO:Cr^{3+} single crystal. The Zeeman patterns were examined experimentally with a magnetic field parallel to the [001], [110] and [111] axes, with linear polarizations parallel and perpendicular to each direction of the magnetic field and with circular polarizations around the magnetic field. Comparing these patterns with those theoretically calculated under reasonable assumptions, it is found that the line is a magnetic dipole radiation due to the $t_2^3\,{}^2E \rightarrow t_2^3\,{}^4A_2$ transition of chromium ions with purely cubic environments. It is also found that the Jahn—Teller coupling of chromophoric electrons and lattice in the excited state may be ignored in explaining the Zeeman effect.

1181 ABSORPTION AND EXCITATION BANDS OF KCl(Tl) IN THE EXTREME ULTRA-VIOLET REGION.

G.Kuwabara and K.Aoyagi.
J. Phys. Soc. Japan, Vol. 14, No. 12, 1821 (Dec., 1959).

Luminescence excitation, absorption and reflectivity spectra of KCl crystals, containing 0.01 to 1 mole % Tl, were measured at 20° and -110° C at photon energies from 5 to 8.3 eV. A new excitation band (D), related to the Tl centre, was observed at 6.89 eV (at 20° C) which shifts towards higher energies at the rate of 1.5 × 10^{-3} eV/deg as the temperature is decreased. The D band is distinct from the exciton band (7.6 eV at 20° C), and its absorptio intensity is similar to the A band (5.04 eV) and varies parallel with those of the A and C bands as the Tl concentration is changed.
J.B.Birk

1182 ELECTRONIC STRUCTURE OF THE CENTERS IN ZnS.

J.L.Birman.
Phys. Rev. (USA), Vol. 121, No. 1, 144-5 (Jan. 1, 1961).

A model of the common sulphide luminescent centres is proposed. The mutual perturbation of crystal eigenstates and transition-metal (activator) d eigenstates is assumed to give rise to the excited and unexcited eigenstates of the centre. For substitutional Cu$^+$(d^{10}) in zincblende, zeroth order crystal field theory predicts that two sets of occupied centre ground-state levels (T$_2$ and E) originating from d^{10} will exist. Additional level splittings result from (a) the spin-orbit effect, and (n) axial crystal field splittings in wurtzite. Experiments on visible and infrared, excitation and emission, are used to make tentative assignments of magnitude of level splittings.

1183 PARTICLE EXCITED LUMINESCENCE IN DIAMOND.

P.J.Dean, P.J.Kennedy and J.E.Ralph.
Proc. Phys. Soc. (GB), Vol. 76, Pt 5, 670-87 (Nov., 1960).

The luminescent effects, excited in the diamond crystals unde bombardment by monoenergetic α- and β-particles and by 50 keV monoenergetic electrons, were investigated for some 50 natural diamonds and for several specimens which had suffered previous radiation damage. The wavelength spectrum in the luminescent emission was measured and also the effect of crystal temperature on this spectrum. Emphasis was placed on the differences betwee the wavelength spectra of the luminescence arising from the different types of excitation and, also, the relative dependence of the wavelength spectra on the condition of the crystal. A comparison was made of the luminescent and conduction counting efficiencies of the crystals. The results indicate the importance, in diamond, c defects which trap the carriers but do not give rise to the emissio of visible or near infrared radiation.

1184 RADIATION INDUCED CHANGES IN THE CATHODOLUMINESCENCE SPECTRA OF NATURAL DIAMONDS.

J.E.Ralph.
Proc. Phys. Soc. (GB), Vol. 76, Pt 5, 688-96 (Nov., 1960).

The effect of 500 keV electron and neutron irradiation on the cathodoluminescence spectra of a number of natural diamonds excited by 70 keV electrons was studied. In certain crystals a line system was induced at 3940 A by 500 keV electron irradiation without annealing. Further systems at 5030 A and 5755 A appeare in all the crystals examined when electron or neutron irradiation was followed by vacuum annealing at temperatures between 600° C and 800° C. The effect of different annealing temperatures was als studied.

1185 THE SCINTILLATION RESPONSE OF ORGANIC SCINTILLATORS FOR 1-2 keV ELECTRONS.

H.H.Kausch-Blecken von Schmeling.
Z. Phys. (Germany), Vol. 160, No. 5, 520-6 (1960). In German.

A method is presented of measuring the scintillation respons of anthracene and organic plastic scintillators. It was found that the scintillation response is a linear function of the electron ener down to energies of 4 or 5 keV. Scintillator thickness and surfac preparation are of great importance in the obtaining of a linear response.

1186 EXCITATION OF ZINC OXIDE BY MEANS OF SLOW ELECTRONS. P.Wachter.
Phys. (Germany), Vol. 161, No. 1, 62-73 (1960). In German.
Under excitation with monochromatic electrons,the lumines- ce of a ZnO phosphor starts with a screen voltage of 2.8 V tact potential 2.4 V), i.e. with an impact energy of 0.4 eV. attering was found in the rise of the fluorescence for screen ages between 7 and 10 V. This can be considered as an inter- on of the incoming electrons with the lattice electrons. The ntum efficiency of electrons having an energy of 10 eV was ut one light quantum per 200 electrons. The work function of was found to be 4 eV.

187 ELECTROLUMINESCENCE MAINTENANCE. W.A.Thornton.
ectrochem. Soc. (USA), Vol. 107, No. 11, 895-907 (Nov., 1960).
The maintenance of several electroluminescent phosphors, ly of the ZnS:Cu,Cl type, was investigated. Data are presented trating its dependence on phosphor properties, such as copper chlorine additions, firing temperature and particle size, on itions of operation, and on lamp construction. Changes in proper- other than light emission and recent maintenance improvements lescribed.

188 MICROSCOPIC OBSERVATIONS ON ELECTROLUMINESCENT ZnS:Cu PHOSPHORS. W.Lehmann.
lectrochem. Soc. (USA), Vol. 107, No. 7, 657-8 (July, 1960).
Qualitative observations were made under a microscope of the troluminescence of a suspension of ZnS:Cu particles in a highly acting medium. Dark segregations were observed in many icles, and the emission spots of electroluminescence were in y cases located at the ends of the segregations. J.B.Birks

189 THE INFLUENCE OF ULTRASONICS ON THE ELECTROLUMINESCENCE OF ZnS:Cu.
żykowski and M.Rozwadowski.
. Acad. Polon. Sci. Ser. Sci. math. astron. phys. (Poland), 7, No. 10, 651-2 (1959).
Observations were made of the effect of ultrasonic vibrations of uency 0.68 Mc/s on the brightness waveform of the electro- inescence stimulated in ZnS:Cu (0.5% by weight Cu) by sinusoidal ls of frequency 0.2 to 5 kc/s. Specimen results are presented. as shown that the effects cannot be ascribed to temperature ations. P.J.Dean

1190 ELECTROLUMINESCENCE OF ZINC SULFIDE SINGLE CRYSTALS. I.T.Steinberger, V.Bar and E.Alexander.
s. Rev. (USA), Vol. 121, No. 1, 118-24 (Jan. 1, 1961).
In a series of experiments designed to distinguish between zation and recombination processes during electroluminescence, angular voltage pulses were applied to single crystals of ZnS. ing the "on" period, the emission gradually increased to a ionary level. Removal of the voltage resulted in a burst of ssion, which decayed slowly. This behaviour is explained by the mption of three field-dependent processes, namely: (a) ioni- on of centres in barrier regions; (b) sweeping out of the liberated trons from the vicinity of the centres; (c) tunnelling of electrons the barrier regions. It was found that for a considerable ge range the product of the light-sum (measured during the "off" od) by the current was proportional to the stationary emission l during the "on" period. This proportionality strongly supports model suggested. In many cases the current was found to be e strongly dependent on the voltage than the light sum. This lt favours an ionization mechanism which is independent of the ent. The model suggests furthermore an alternative explanation he Neumark-effect, i.e., the enhancement of the thermal glow by ric fields. The explanation does not involve an impact-ionization anism.

MAGNETIC PROPERTIES OF SOLIDS

191 EFFECT OF IMPURITIES ON THE ENERGY SPECTRUM OF ELECTRONS IN BISMUTH.
Brandt and M.V.Razumeenko.
ksper. teor. Fiz. (USSR), Vol. 39, No. 2(8), 276-84 (Aug., 1960). ssian.
The influence of small amounts of Pb impurities on the quantum oscillations of the magnetic susceptibility of Bi was investigated at 1.7-4.2°K and for various orientations of the magnetic field relative to the crystallographic axes of the samples. It was found that with increase of the concentration of Pb up to 0.037 wt. % the shape of the Fermi surface and the electron effective mass tensor practically do not change, whereas the Fermi energy and the electron concentration decrease with growth of the concentration of Pb. It is shown that the change in the anisotropy of the magnetic susceptibility of Bi which occurs with increase of the Pb impurities cannot be explained by changes of the electron and hole parameters and that the experimentally observed dependence of the susceptibility and its anisotropy on the Pb content can be fully explained by Adams' suggestion that the Bi valency band is strongly diamagnetic. [English translation in: Soviet Physics—JETP (USA)].

1192 ON THE MAGNETIC SUSCEPTIBILITIES OF SOME ORGANIC SULFUR COMPOUNDS. K.Yoshida.
Sci. Rep. Res. Insts Tohoku Univ. A (Japan), Vol. 11, No. 5, 422-31 (Oct., 1959).
Magnetic susceptibilities of ten organic sulphur compounds were measured by use of the Gouy-balance, and the structures of these compounds are discussed. The compounds are tetramethylthiuram disulphide (I), tetramethylthiuram monosulphide (II), dixanthogene (III), sodium diethyldithiocarbamate (IV), sodium butyltrithiocarbonate (V), thiobenzophenone (VI), 2-mercaptobenzothiazole (VII), dibenzothiazolyl-2-disulphide (VIII), benzothiazolyl-N'-cyclohexylsulphenamide (IX) and trithioacetone (X). They were found to be all diamagnetic. The atomic increment of double bond sulphur was evaluated as -11.1×10^{-6} c.g.s.u., from the experimental values of compounds indicated by (IV, V) and (VI). The six compounds (I, II III, VII, VIII) and (IX) showed large diamagnetic exaltation, suggesting molecular π-electron orbitals. The compound (X) was found to have the single bond sulphur rather than the double bond sulphur, suggesting the cyclic structure.

1193 MAGNETIC SUSCEPTIBILITY OF THE TWO PHASES OF LITHIUM AT LOW TEMPERATURES.
F.T.Hedgcock.
Phys. Rev. Letters (USA), Vol. 5, No. 9, 420-3 (Nov. 1, 1960).
Measurements of the magnetic susceptibility of lithium, corrected for small amounts of ferromagnetic and paramagnetic impurity, suggest that there is a change in susceptibility of about 24% in the transition from the body-centred cubic to the close-packed hexagonal phase. A.J.Manuel

1194 A MAGNETIC SUSCEPTIBILITY BALANCE AND THE TEMPERATURE DEPENDENCE OF THE MAGNETIC SUSCEPTIBILITY OF COPPER, SILVER, AND GOLD, 295°-975°K.
M.Garber, W.G.Henry and H.G.Hoeve.
Canad. J. Phys., Vol. 38, No. 12, 1595-1613 (Dec., 1960).
A magnetic susceptibility balance is described which has a reproducibility of better than ±0.15%. The temperature dependence of the magnetic susceptibility of copper, silver, and gold from 295° to 975°K is reported.

1195 THE MAGNETIC SUSCEPTIBILITY OF VANADIUM—CHROMIUM SOLID SOLUTIONS.
B.G.Childs, W.E.Gardner and J.Penfold.
Phil. Mag. (Eighth Ser.)(GB), Vol. 5, 1267-80 (Dec., 1960).
The magnetic susceptibilities of a number of solid solutions of chromium in vanadium were measured at 20°, 77° and 293°K. The susceptibility at 20°K decreased with concentration from a value of 300×10^{-6} e.m.u./g-atom for pure vanadium to 159×10^{-6} e.m.u./g-atom for pure chromium. Fine structure was observed in several regions of the susceptibility—composition curve. The temperature dependence of the susceptibility of all the alloys investigated was small. An interpretation of the susceptibility behaviour is given in terms of the collective electron model.

1196 MAGNETIC STUDIES ON SINGLE-CRYSTAL CHROME POTASSIUM ALUM BELOW 1° KELVIN. A.C.Thorsen.
Phys. Rev. (USA), Vol. 121, No. 1, 66-71 (Jan. 1, 1961).
The magnetic susceptibility of a spherically shaped single crystal of chrome potassium alum was measured as a function of entropy and applied external field along the [100], [110], and [111] directions in the crystal at temperatures below 0.1°K. Zero-field measurements of the static susceptibility were made with a moving coil apparatus and longitudinal field measurements were made using the conventional ballistic bridge method. A ballistic galvanometer with period 4.6 sec was used in both circuits. Drop coil measurements indicate no long-time effects in the magnetization and show no

appreciable difference from the susceptibility measured by the ballistic method. The isentropic susceptibility measured in fields up to 300 G indicates definite anisotropy below the Néel point in fields from 50 to 300 G.

1197 HYPERFINE STRUCTURE OF Fe^{57} IN PARAMAGNETIC AND ANTIFERROMAGNETIC FeF_2 FROM THE MÖSSBAUER EFFECT. G.K.Wertheim.

Phys. Rev. (USA), Vol. 121, No. 1, 63-6 (Jan. 1, 1961).

Measurements of the gamma-ray resonant absorption in oriented slabs of FeF_2 were used to determine the magnitude and direction of the magnetic field at the iron nucleus in the antiferromagnetic state (3.40×10^5 Oe at 0^0K) and the quadrupole splitting in the paramagnetic state (31.2 Mc/s) of this material. The observed electric and magnetic h.f.s. in the antiferromagnetic state is interpretable in terms of an asymmetric electric field gradient tensor with its major axis perpendicular to the c axis, an asymmetry parameter of 0.33, and a quadrupole splitting of 30.3 Mc/s at 45^0K.

1198 CORRELATION OF LOW-TEMPERATURE CALORIC AND MAGNETIC EFFECTS IN TiFe.

K.Schröder and C.H.Cheng.

J. appl. Phys. (USA), Vol. 31, No. 12, 2154-5 (Dec., 1960).

Magnetic measurements by Nevitt on TiFe can be interpreted on the assumption that his specimen is superparamagnetic. It is possible to calculate from his measurements approximate values of the size and number of ferromagnetic clusters. The magnetization vector of these cluster oscillates at very low temperatures within directions given by the energy of crystal anisotropy. This gives rise to the term C_{cl} in the specific heat at low temperatures, due to the clusters, which is to be added to the lattice and electronic terms. The calculation gives reasonable agreement of C_{cl} with experimental values found in specific heat measurements.

1199 GENERAL SPIN-WAVE DISPERSION RELATIONS. R.F.Soohoo.

Phys. Rev. (USA), Vol. 120, No. 6, 1978-82 (Dec. 15, 1960).

The general spin-wave dispersion relation obtained by a simultaneous solution of the equation of motion of the magnetization and Maxwell's equations is given. In contrast to previous calculations, the effects of conductivity, relaxation, exchange, and propagation are all properly taken into account. The resulting algebraic equation, being biquadratic in the square of the wave number, k^2, has four possible pairs of solutions. Some of these solutions correspond to growing plane waves while others represent attenuated ones in the direction of propagation. Whereas an analytical solution for k could be easily obtained for the special case where the wave vector $\vec{k}$ is in the direction of the static magnetic field ($\theta_k = 0$), the solution for the cases where $\theta_k \neq 0$ could be conveniently obtained only by numerical solution. The solutions for the latter cases have been obtained by using an I.B.M. 709 computer and some of the representative results are given in graphical form. When relaxation and eddy current damping are neglected, this result reduces to that of Herring and Kittel (Abstr. 4525 of 1951) in the static limit ($\omega \to 0$). Furthermore, it was found that the uniform precessional mode ($k = 0$) can truly exist only under very special conditions, namely, under the condition of zero permeability for one of the two normal modes in a gyromagnetic medium.

1200 EQUIVALENCE OF THE CRITICAL CONCENTRATIONS IN THE ISING AND HEISENBERG MODELS OF FERROMAGNETISM.

R.J.Elliott, B.R.Heap, D.J.Morgan and G.S.Rushbrooke.

Phys. Rev. Letters (USA), Vol. 5, No. 8, 366-7 (Oct. 15, 1960).

The critical concentration for zero Curie temperature in a mixture of magnetic and nonmagnetic atoms is shown to be a topological property of the lattice and to be independent of the model and the spin value. E.P.Wohlfarth

1201 ELECTRICAL AND MAGNETIC PROPERTIES OF SOME LOW-CONDUCTIVITY FERRO- AND PARAMAGNETIC SUBSTANCES AT MICROWAVE FREQUENCIES.

F.Rahman and C.Ranjan.

Pakistan J. sci. Res., Vol. 12, No. 2, 87-92 (April, 1960).

1202 COVALENT SUPER-EXCHANGE IN SOLID STATE PHYSICS. W.S.Fyfe and J.Verhoogen.

Nature (GB), Vol. 187, 1108 (Sept. 24, 1960).

A table is given of ferromagnetic (F) and antiferromagnetic (A) compounds of elements in the first transition series with O, S, Se, Te, As, Sb, Bi, noting in each case whether the compound is F or A and the number of electrons, n, participating in covalent bonding. The value of n is calculated by the formula $n = n'(q/p) + n''$, where is the number of electrons in the upper 3d-levels of the cation, p an q are the respective coordination numbers of the cations and anion and n'' is the number of valence electrons of the anion. It is noted that those compounds with n even tend to be A and those with n odd tend to be F. An explanation is put forward. D.M.Edwar

1203 FERROMAGNETIC AND ANTIFERROMAGNETIC BEHAVIOUR IN THE SECOND TRANSITION GROUP.

B.R.Coles and D.Griffiths.

Nature (GB), Vol. 187, 226-7 (July 16, 1960).

A 1% Ag—1% Rh—Pd alloy exhibits a spontaneous magnetization below 160^0K. It is suggested that palladium possesses some antiferromagnetic character which is disturbed by the alloying to give a weak ferromagnetic moment. An alloy containing 5% each of Rh a Ag shows similar anomalies at lower temperatures but a 5% Rh—Pd alloy does not. D.J.Olive

1204 THE EFFECT OF THE SHAPE OF FERROMAGNETIC BODIES ON THE COERCIVE FORCE OF THE MATERIALS OF THOSE BODIES AFTER ANNEALING.

D.D.Mishin and I.I.Matantseva.

Fiz. Metallov i Metallovedenie (USSR), Vol. 9, No. 2, 184-6 (Feb., 1960). In Russian.

Rectangular sheets of cold- and hot-rolled steel of various lengths and widths, and of thickness 0.1 mm and 0.35 mm are annealed by heating above the Curie point, to 800^0C, remaining at that temperature for 15 minutes, and cooling to 400^0C, at about 150^0C per hour. The long dimension of each sheet is either along or perpendicular (1) to the direction of rolling, or (2) to a direction making 55^0 with that of rolling. Rectangular pieces of size 30 × 6 mm are then cut out. Their coercive forces are measured, and found to differ greatly with the shape and orientation of the initial sheets. A table is given. Similar results may be expected for the permeability and other magnetic properties. N.Da

1205 RETARDED AND ADVANCED GREEN FUNCTIONS IN THE QUANTUM THEORY OF ISOTROPIC FERROMAGNETICS.

Pu Fu-Cho[P'u Fu-Ch'o], S.V.Tyablikov and T.Shiklosh[Siklós].

Acta phys Hungar., Vol. 11, No. 4, 323-31 (1960). In Russian.

Retarded and advanced Green functions have been used for the calculations of the fundamental thermodynamical characteristics of isotropic ferromagnetics. By this method results are obtained for the magnetization which are valid for all temperatures. It is not assumed that the orientation of the resulting magnetization with respect to the external magnetic field is known in advance. This allows the investigation of more complicated problems in the theory of magnetism.

1206 SOME MAGNETIC PROPERTIES OF THE SUBSTANCE $FeSe_{1+x}$. I.Maxim.

Stud. Cercetari Fiz. (Roumania), Vol. 9, No. 3, 323-9 (1958). In Roumanian.

Reports results of susceptibility measurements on these substances which crystallize in the NiAs structure for x between 0.04 and 0.35. As x increases the hexagonal sublattice containing the iron atoms contains an increasing vacancy concentration. For $x >$ the substances are ferromagnetic up to about 150^0C with a moment proportional to x. Between this temperature and about 575^0C the substances are antiferromagnetic, with a pronounced susceptibility maximum, and at higher temperatures paramagnetic with a large Curie temperature. E.P.Wohlfart

1207 THE MAGNETIZATION OF FERROMAGNETIC BINARY ALLOYS OF COBALT OR NICKEL WITH ELEMENTS OF THE PALLADIUM AND PLATINUM GROUPS.

J.Crangle and D.Parsons.

Proc. Roy. Soc. A (GB), Vol. 255, 509-19 (May 10, 1960).

The spontaneous magnetization at the absolute zero and Curie point of the face-centred cubic phase in the binary alloys of Pd, R Ru, Pt, Ir and Os in cobalt and of Rh, Ir and Os in nickel were me sured as a function of composition, and older measurements on P Ru and Pt in nickel were re-assessed. The significance of the me surements in relation to various simple models is discussed.

MÖSSBAUER ABSORPTION IN FERROMAGNETIC Mn—Sn ALLOY: NUCLEAR ZEEMAN EFFECT. See Abstr. 621

1208 THE MAGNETIZATION OF NICKEL AT LOW TEMPERATURES. E.P.Wohlfarth and J.F.Cornwell.

rromagnetism Working Party, Berlin, 1959 (see Abstr. 18171 of
50), p. 9-14.

The data of Foner and Thompson [Abstr. 2985 of 1960; Lincoln
boratory Report, No. JA-1116 (1958)] are discussed. Deviations
m the $T^{3/2}$ spin wave law of approach are larger than those pre-
ted by Dyson (Abstr. 5998-9 of 1956) and it is shown that these
viations may arise, at least in part, as a result of a contribution
m collective electron ferromagnetism. The law of approach in
s treatment is considered and is found to be sensitive to the
ues of the various inherent parameters. By considering the
gnetization data for nickel on the one hand and those for gado-
ium on the other, an experimental determination of the low
nperature magnetization of iron is suggested as a possible method
deciding on the electronic structure of this metal.

1209 EFFECT OF FIRE ON THE MAGNETIC PROPERTIES OF SOIL AND ON THOSE OF SCHIST AND GRANITE.

Le Borgne.
n. Geophys. (France), Vol. 16, No. 2, 159-95 (1960). In French.

By means of combustion at the surface of soils, the effects of
e on the magnetic properties of soil appear to be limited in depth
t intense near the surface. Various soils were heated in the
boratory in order to determine the best conditions for the form-
ion of magnetic components. At the temperatures experimented
th, (300°-700°C), magnetic products were best obtained by heating
a reducing atmosphere, then cooling in an oxidizing one; this
rresponds fairly well to the baking conditions which occur in
rning soils. It is suggested as an explanation for the effect of fire
the magnetic susceptibility of soil that a series of transformations
the following type occur: $Fe_2O_3\alpha \rightarrow Fe_3O_4 \rightarrow Fe_2O_3\gamma$. Schist and
anite samples were heated in the same conditions as the soils.
e behaviour of schist was similar to one of the soils; the behaviour
unweathered granite was very different.

1210 TEMPERATURE DEPENDENCE OF THE INTERNAL FIELD IN FERROMAGNETS. D.E.Nagle, H.Frauenfelder,

D.Taylor, D.R.F.Cochran and B.T.Matthias.
ys. Rev. Letters (USA), Vol. 5, No. 8, 364-5 (Oct. 15, 1960).

The internal field was investigated in iron and a Co—Pd alloy
ing the Mössbauer effect and was found to be proportional to the
turation magnetization, thus verifying directly the Weiss hypo-
esis.

E.P.Wohlfarth

1211 LINEAR DECREASE IN THE MAGNETOCRYSTALLINE ANISOTROPY. C.Abraham and A.Aharoni.

ys. Rev. (USA), Vol. 120, No. 5, 1576-9 (Dec. 1, 1960).

In a previous paper (Abstr. 11839 of 1960) an attempt was
ide to reduce the theoretical coercive force by assuming that the
gnetocrystalline anisotropy constant vanished in a certain re-
on. A modification of this assumption was made in the present
rk, namely, the magnetocrystalline anisotropy was taken as zero
a part of the "imperfection" region and assumed to increase
early to its constant value in the remaining part. The coercive
rce is calculated as a function of two parameters: the dimen-
ons of the zero and linear parts of the imperfection region. A
ther reduction in the coercive force was obtained with respect
the previous case, but there is a large discrepancy between the
culated and experimental values, for reasonable defect size.

1212 ANOMALIES OF THE ISOTHERMAL INITIAL MAGNETIZATION. O.Yamada.

R. Acad. Sci. (France), Vol. 251, No. 6, 860-2 (Aug. 8, 1960).
French.

The magnetization in the Rayleigh region corresponding to an
therm at temperature T_b, obtained after demagnetization at tem-
rature T_a, is larger when $T_b > T_a$ then when $T_b \leq T_a$.

E.P.Wohlfarth

1213 THE EXISTENCE OF "TWO CURIE POINTS" IN Fe—Al ALLOYS. Sh.I.Zusman.

z. Metallov i Metallovedenie (USSR), Vol. 9, No. 4, 635-7 (April, 1960)
Russian.

The validity is questioned of the conclusions reached by Sykes
d Evans [Abstr. 1268 of 1935 B; J. Iron Steel Inst. (GB), Vol. 31,
5 (1935)] who, having ignored the anomalous increase of the co-
cive force of Fe_3Al at 450-500° C, had inferred the existence of
Curie points in this alloy from thermomagnetic curves, obtained
relatively weak (H = 15 Oe) fields. The effect is illustrated of the anomalous increase in coercivity by two series of hysteresis loops, obtained for slowly cooled specimens in weak and strong fields (15 and 100 Oe, respectively), and it is shown that Fe_3Al has, in fact, one Curie point only.

M.H.Sloboda

1214 THE MAGNETIC SUSCEPTIBILITY OF A SOLID SOLUTION OF FERROUS OXIDE IN MAGNESIUM OXIDE. G.Grossmann and S.M.Ariya.

Fiz. tverdogo Tela (USSR), Vol. 2, No. 10, 2477-9 (Oct., 1960). In Russian.

The magnetic susceptibilities χ of various solid solutions of oxides of iron in magnesium oxide, having the formula $FeO_{1+x}.zMgO$, were measured at 700, 800 and 900° C by a method described earlier. With these and previously obtained results, three sets of graphs of χ against x are plotted, one set for each temperature, over the range $0 < x < 0.5$, and with z = 0, 0.487 and 0.925. Straight line graphs are obtained, which, extrapolated to x = 0, intersect at one point. From these and other intersections, deductions are made relating to the state of aggregation of the iron atoms, the value of χ, and the composition of the substance. [English translation in: Soviet Physics—Solid State (1959)].

N.Davy

1215 ELECTRONIC MAGNETOANALYSIS OF AN IRON SINGLE CRYSTAL. S.Yamaguchi.

J. Electrochem. Soc. (USA), Vol. 107, No. 8, 714-15 (Aug., 1960).

There is a constant relation between the orientation of an iron crystal and the iron oxide film which exists on the surface so that the position of the iron crystal axis can be obtained by an examination of a replica obtained from the oxide. The B—H curve can be obtained from the deflection of an electron beam grazing the crystal surface.

D.J.Oliver

1216 MAGNETIC VISCOSITY AND ANNEALING IN MAGNETIC FIELD.

G.Biorci, A.Ferro and G.Montalenti.
Nuovo Cimento (Italy), Vol. 18, No. 2, 229-40 (Oct. 16, 1960).

It is shown that a sufficient, but not necessary condition, such as a magnetic material exhibits magnetic annealing is that it presents also, in a proper temperature range, diffusion magnetic viscosity. Besides, if H_t is the maximum value of the viscosity field, the energy H_tJ_s is nearly equal to the anisotropy energy K_u induced by annealing in a magnetic field, at least for measurements performed at the same temperature. It is also shown that the anomalies of specific heat, associated with the process of annealing, are so small that they cannot be observed experimentally. The experimental verifications are made on iron containing interstitial carbon. The values of the energy H_tJ_s, obtained from the measurement of the maximum value of the viscosity field, are lower than, but of the same order of magnitude as those of the induced anisotropy constant, measured directly. If one considers the poor accuracy with which K_u could be determined the agreement obtained is satisfactory.

1217 MAGNETIC ANNEALING EFFECT IN $\alpha\, Fe_2O_3$. T.Iwata, M.Iwata and M.Yamamoto.

J. Phys. Soc. Japan, Vol. 14, No. 6, 855-6 (June, 1959).

A disk of pure α-ferric oxide was prepared by sintering α-Fe_2O_3 powder in oxygen at 1000° C and cooling it in air from above its Néel temperature down to room temperature in an applied field of 440 Oe. A field of 6700 Oe was subsequently applied perpendicular to the annealing field and torque curves obtained by clockwise and anti-clockwise rotation in fields H up to 6000 Oe. Uniaxial magnetic anisotropy was observed along the direction of the original annealing field, maximum values being obtained for $H \cong 4000$ Oe. It is claimed that these results support the view that parasitic ferromagnetism in Fe_2O_3 arises from ferromagnetic layers of a second phase in "exchange contact" with the antiferromagnetic matrix. The uniaxial anisotropy arises from an alignment in the matrix with the ferromagnetic layers during the cooling process and the decrease of anisotropy with H is ascribed to the rotation of the antiferromagnetic vector when H exceeds a critical value.

R.Parker

1218 ON THE LAW GOVERNING THE IRREVERSIBLE CHANGES OF MAGNETIZATION PRODUCED BY THERMAL CYCLING. O.Yamada.

C.R. Acad. Sci. (France), Vol. 251, No. 5, 662-4 (Aug. 1, 1960). In French.

It is shown that, in the Rayleigh region of the initial magnetization curves, the irreversible variation of magnetization is proportional to the strength of the magnetization and the amplitude of the temperature variation. S.A.Ahern

1219 THERMOMAGNETIC TREATMENT AND ORDERING PROCESSES. IV. INVESTIGATION OF THE EFFECT OF THERMOMAGNETIC TREATMENT ON THE LATTICE PARAMETERS OF SOFT MAGNETIC ALLOYS UNDERGOING THE DISORDER—ORDER TRANSFORMATION.

A.A.Glazer, L.M.Magat and Ya.S.Shur.

Fiz. Metallov i Metallovedenie (USSR), Vol. 9, No. 3, 467-9 (March, 1960). In Russian.

The coercive force, H_c, saturation magnetostriction, λ_s, and lattice parameters of Perminvar and Permalloy 78, cooled slowly (200°C/h) from 700 to 300°C with and without the application of a magnetic field, were measured. Whereas H_c and λ_s of alloys subjected to thermomagnetic treatment were considerably higher than those of specimens that had undergone the disorder—order transformation in the absence of the magnetic field, the lattice parameters were the same after both treatments. The results indicated that only a small number of atoms participates in the process of establishing magnetic uniaxiality in the course of the thermomagnetic treatment, and that the ordering transformation plays no significant part in the mechanism of this treatment. M.H.Sloboda

1220 MAGNETOTHERMAL EFFECTS IN SILICON—IRON ALLOYS.

N.H.Saunders and R.S.Tebble.

Proc. Phys. Soc. (GB), Vol. 76, Pt 2, 282-94 (Aug., 1960).

Reports measurements of the reversible magnetothermal effect in two alloys of silicon—iron. Analysis of the measurements by the method of Stoner and Rhodes (1949), though hindered by the absence of reliable data on the basic magnetic constants of the materials, showed that, over the field-range studied, the experimental coefficient b'' was nowhere constant but tended to the "rotational" value $b = (T/K_1)(\partial K_1/\partial T)$ as the field increased. The possibility was considered that the variation was associated with changes in a "spike" domain structure. It was concluded that such a structure may have been involved but could not, by itself, account for the details of the observations.

1221 THERMALLY ACTIVATED FERROMAGNETIC DOMAIN WALL MOTION.

F.D.Stacey.

Austral. J. Phys., Vol. 13, No. 3, 599-601 (Sept., 1960).

The data of Olmen and Mitchell (Abstr. 3053 of 1960) on slow wall motions in thin films are interpreted quantitatively on the basis of thermal fluctuation effects. The experimental dependence of the wall speed on switching field is explained, and a value of the coercive force, agreeing with that observed, is derived. E.P.Wohlfarth

1222 DOMAIN PATTERNS ON "CUBE-TEXTURED" SILICON—IRON SHEET.

L.F.Bates and R.Carey.

Proc. Phys. Soc. (GB), Vol. 76, No. 5, 754-8 (Nov., 1960).

The surface domain structure of a cube-textured 3% silicon—iron sheet was examined by the colloid technique. The patterns observed on most grains were typical of those previously reported on (100) surfaces in the single crystals, i.e. most grains contained two easy axes of magnetization in the surface, and usually one of these was parallel to the rolling direction of the sheet. A new band-structure pattern was found, and by comparison with similar patterns on a single crystal was thought to be associated with bulk strain in the material.

1223 MAGNETORESISTIVE MEASUREMENTS ON DOMAIN ROTATION IN NICKEL—IRON ALLOY FILMS.

F.G.West.

Nature (GB), Vol. 188, 129-30 (Oct. 8, 1960).

The magnetoresistance of thin films is shown theoretically and experimentally to be a parabolic function of the reduced field applied in the hard direction, and the values of the anisotropy field so obtained agree with those deduced from the transverse susceptibility. E.P.Wohlfarth

1224 THE USE OF THE AMPLIFIED MAGNETO-OPTICAL KERR EFFECT FOR RENDERING VISIBLE THE MAGNETIC DOMAINS IN POLYCRYSTALLINE COBALT AND NICKEL.

J.Kranz and A.Schauer.

Naturwissenschaften (Germany), Vol. 47, No. 17, 392-3 (1960). In German.

It was shown in an earlier paper (Abstr. 8117 of 1958) that the Kerr rotation in silicon iron may be magnified by the evaporation of thin surface layers to such an extent as to render visible the Weiss domains. Photomicrographs are now presented of domains in polycrystalline cobalt and in nickel. These could be observed after evaporating zinc sulphide onto the metal surfaces. The magnifica tion of the rotation obtained in this way was roughly a factor ten. R.Par

1225 THE SATURATION MAGNETOSTRICTION CONSTAN OF NICKEL WITHIN THE TEMPERATURE RANGE −196° TO 365°C.

R.R.Birss and E.W.Lee.

Proc. Phys. Soc. (GB), Vol. 76, Pt 4, 502-6 (Oct. 1, 1960).

The spontaneous megnetostriction of cubic crystals can be expressed in the form

$$\lambda = C_0 + C_1(\alpha_1^2\beta_1^2 + \alpha_2^2\beta_2^2 + \alpha_3^2\beta_3^2) + \\ + C_2(\alpha_1\alpha_2\beta_1\beta_2 + \alpha_2\alpha_3\beta_2\beta_3 + \alpha_3\alpha_1\beta_3\beta_1),$$

where the α_i and β_i are, respectively, the direction cosines of th magnetization vector and the measuring direction, with respect the crystal axes. The coefficients C_1 and C_2 were determined fo nickel within the temperature range −196°C to the Curie point (365°C) using calibrated strain gauges. At −196°C, $C_1 = -85.0$ and $C_2 = -85.4 \times 10^{-6}$. Both constants increased monotonically zero at 365°C. The room temperature (20°C) values were $C_1 = -77.2 \times 10^{-6}$ and $C_2 = -70.0 \times 10^{-6}$. For a polycrystal the spontaneous magnetostriction may be expressed in the form

$$\lambda = C + \tfrac{3}{2}\lambda_S \cos^2 x,$$

where x is the angle between α and β. Measurements of λ_S were made in the same way and they were in good agreement with the values calculated assuming uniform stress, namely $\lambda_S = \frac{4}{15}C_1 + \frac{1}{5}$

1226 MAGNETIC VISCOSITY DUE TO SOLUTE ATOM PA I. THEORY OF THE EFFECT.

G.Biorci, A.Ferro and G.Montalenti.

J. appl. Phys. (USA), Vol. 31, No. 12, 2121-5 (Dec., 1960).

It is shown that solute atom pairs in ferromagnetic alloys, a well as the interstitial atoms in iron, can give magnetic viscosit The viscosity field of the alloys versus wall displacement is det mined for various crystal structures. The maximum value of th viscosity field is related to the anisotropy energy induced in the same materials by heat treating in a magnetic field.

1227 OBSERVATIONS OF DEFECTS BY MAGNETIC VISCOSITY IN NEUTRON IRRADIATED PURE IRON

P.Moser, D.Dautreppe and P.Brissonneau.

C. R. Acad. Sci. (France), Vol. 250, No. 24, 3963-5 (June 13, 19 In French.

Magnetic viscosity caused by diffusion at room temperature revealed defects with an activation energy of 1.2 eV after neutro irradiation in a pile at room temperature. Similar effects, with defect activation energy of 0.3 eV are observed close to 90°K ai irradiation at 78°K. S.A.A

1228 DISPERSION RELATION FOR SPIN WAVES IN A F.C COBALT ALLOY.

R.N.Sinclair and B.N.Brockhouse

Phys. Rev. (USA), Vol. 120, No. 5, 1638-40 (Dec. 1, 1960).

The technique of neutron spectrometry was used to measure dispersion curve of the spin waves in a metal for the first time. momentum distributions of inelastically scattered neutrons from single crystal of f.c.c. cobalt containing 8% of iron were observe under constant energy transfer conditions. The observed neutro groups (which satisfied momentum and energy conservation betw the neutrons and the spin-wave quanta) enabled the dispersion re tion to be established. The response of the intensity of the neutr groups to an applied magnetic field was used to identify those of spin-wave origin. The dispersion relation is in agreement with form predicted by the Bloch—Heisenberg spin-wave theory. Ove the range of measurements, which was limited by the available s trum of neutron energies, approximate isotropy was observed to hold. The value of the product of the exchange integral and the atomic spin is found to $JS = (1.47 \pm 0.15) \times 10^{-2}$ eV. Assuming $S = 0.92$ the value for J is in poor agreement with a value obtain from the spin-wave interpretation of low-temperature magnetiza data. Study of the widths of the neutron groups leads to the conc sion that the mean lifetimes of some of the spin waves are great than 3×10^{-13} sec.

1229 MAGNETIC PROPERTIES OF THIN FERROMAGNE FILMS.

H.Thomas.

Ferromagnetism Working Party, Berlin, 1959 (see Abstr. 18171 1960) p. 86-103. In German.

A valuable review of the following topics: Spontaneous mag

ization and Curie temperature, anisotropy, domain and domain
lls, hysteresis, dynamic properties. 123 references.

E.P.Wohlfarth

1230 ON THE INVESTIGATION OF SLOW MAGNETIZATION PROCESSES IN THIN FILMS. W.Hellenthal.

urwissenschaften (Germany), Vol. 47, No. 16, 371 (1960).
German.

Changes in the technical magnetization of thin films are
dily detected by a change in the plane of polarization of trans-
cted light. A nickel film 90 A thick was deposited on a glass plate
200° C, magnetized to saturation and then subjected to a small
erse field, H_g. The subsequent rotation of the plane of polariza-
n of transmitted light was studied in a time interval from 10 sec
a day after the field reversal. A reversal of magnetization occurs
ntually as a result of thermal activation. A logarithmic relation-
p exists between H_g and the time required for the film to pass
ough the coercive point. The present experiment supplements
. measurements of the coercive field.

R.Parker

1231 MAGNETIC PROPERTIES OF EPITAXIALLY GROWN FILMS. O.S.Heavens.

search (GB), Vol. 13, No. 10, 404-10 (Oct., 1960).

The possible advantages of using epitaxially grown films in
dies of thin film properties are discussed; with particular refer-
ce to magnetic properties. Methods suitable for magnetic meas-
ements are described and a summary of the types of result ob-
ned is given. Preliminary results are given of measurements of
Faraday rotation in epitaxially grown nickel films.

1232 ON THE FORM OF THE EXPRESSION FOR THE MAGNETOELASTIC ENERGY OF FERROMAGNETICS.

A.Ignatchenko and S.V.Vonsovskii.
. Metallov i Metallovedenie (USSR), Vol. 9, No. 3, 456-7 (March,
60). In Russian.

Theoretical. A small inaccuracy in the formula for the density
magnetoelastic energy, due to Becker and Doering (Ferromagnet-
nus. Berlin : 1939), is discussed. It is shown that in deriving
s formula it is not permissible to neglect the term $-\frac{1}{3}\Sigma\sigma_{ii}$ in the
ression for that part of the energy of ferromagnetic anisotropy
ch depends on the first stages of forced deformations.

M.H.Sloboda

1233 GYROMAGNETIC RATIOS OF MANGANESE ALLOYS. G.G.Scott.

s. Rev. (USA), Vol. 121, No. 1, 104 (Jan. 1, 1961).

The gyromagnetic ratios of two different ferromagnetic alloys
nanganese were measured by Einstein—deHaas experiments. The
sler alloy Cu_2MnAl gave a g' value of 1.993 ± 0.002. The alloy
Sb gave a g' value of 1.978 ± 0.002.

1234 CONSIDERATIONS ON THE PROPAGATION AND GENERATION OF MAGNETOSTATIC WAVES AND SPIN AVES. P.C.Fletcher and C.Kittel.

ys. Rev. (USA), Vol. 120, No. 6, 2004-6 (Dec. 15, 1960).

A discussion is given of the dispersion relation, magnetization
stribution, and group velocity of magnetostatic waves in an infinite
rcular cylinder with the static magnetic field parallel to the
linder axis. The dispersion relation of the modes with $e^{i\varphi}$ angular
pendence is, for $kR \gg 1$,

$$\omega \cong {}_{\gamma}H_0 + {}_{\gamma}2\pi M_S(x_i/kR)^2 + (D/\hbar)k^2,$$

ere x_i is a root of $J_0(x) = 0$; R is the cylinder radius; and D is the
change constant. The group velocity of magnetostatic pulses at
v wave vectors is shown to be considerably higher than magnon
locities.

1235 PERMANENT MAGNETS WITH HIGH COERCIVITY BASED ON Fe—Co—Ni—Al alloys.

.J.Koch, M.G. van der Steeg and K.J. de Vos.
romagnetism Working Party, Berlin, 1959 (see Abstr. 18171 of
)). p.130-39. In German.

The influence on the magnetic properties of additionals
Ti, Nb, Ta) and the treatment (normal or isothermal field
tment, crystal orientation) is investigated, and the relation with
fine structure established by X-ray and electron-microscopical
stigation of the phases. In the state of optimum hardness only
two b.c.c. phases are present, and the precipitate particles are
gated and very well aligned.

E.P.Wohlfarth

1236 STRUCTURE AND PROPERTIES OF ALNICO AND E.S.D. PERMANENT MAGNETS. T.O.Paine.

Ferromagnetism Working Party, Berlin, 1959 (see Abstr. 18171 of 1960), p. 124-9.

Both E.S.D. (Elongated Single-Domain) particles and Alnico 5 DG appear to derive their coercive force from the shape anisotropy of an elongated 100-400 A single-domain magnetic structure. The variation in magnetic properties with measurement angle and electron micrographs are consistent with the view that magnetization reversal takes place by a buckling process apparently nucleated at structural irregularities and interparticle cross-links. Ticonal XX exhibits a magnetic behaviour more consistent with coherent rotation; this may be associated with its more perfect structure which leads to a high coercivity and energy product by minimizing buckling nucleation points.

1237 ON THE MAGNETIC CHANGE IN RESISTANCE OF FERROMAGNETICS ABOVE THE CURIE POINT.

I.K.Kikoin, N.A.Babushkina and T.N.Igosheva.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 4(10), 1172-4 (Oct., 1960). In Russian.

The alloy Cr—Te is ferromagnetic with a Curie point T_C near 50° C. Its paramagnetic susceptibility above T_C obeys the Curie—Weiss law $\chi(T - \Theta p) = c$, where $\Theta p = 80^{\circ}C$. The relative change in electric resistance, on being placed in a magnetic field, was measured. Δr proved to be always negative above (and below) T_C. Above T_C, it was found that the law $-\Delta r/r = a\sigma^2$ held over a wide range of temperature. It had been found earlier that below T_C the law $-\Delta r/r^2 b(\sigma^2 - \sigma_0^2)$ held, where σ_0 is the spontaneous magnetization. Since above T_C, $\sigma_0 = 0$, one can regard the same law as holding above and below that point. Also the experimental values of a and b nearly coincide. [English translation in: Soviet Physics—JETP (USA)].

N.Davy

1238 OBSERVATION OF THE SPONTANEOUS COHERENT RADIATION OF A FERRITE IN A RESONATOR.

A.P.Aleksandrov, Ya.I.Khanin and É.G.Yashchin.
Zh. eksper. teor. Fiz. (USSR), Vol. 38, No. 4, 1334-7 (April, 1960). In Russian.

A method of exciting ferrites in place of paramagnetics, so that they emit spontaneous coherent radiation from their electron spin systems, in the ultra high frequency range, is developed. This is based on the fact that resonance excitation of a ferrite occurs at a frequency ν_1 differing from ν_2, the frequency of the spontaneous radiation. The acts of excitation and radiation are separated by a time interval t_2-t_1, in the course of which the external magnetic field is changed from $H_1 = 2\pi\nu_1/\gamma$ to $H_2 = 2\pi\nu_2/\gamma$ where γ is the electron gyromagnetic ratio. This is done by superposing an impulsive magnetic field on the constant field H_0 of an electromagnet. An oscillogram shows a largish peak due to the spontaneous radiation and two smaller ones due to ferromagnetic resonance occurring when $H = H_1$, near the beginning and end of the impulse.

N.Davy

1239 ON THE MAGNETIC PROPERTIES OF THE ORTHOFERRITES OF LANTHANUM AND PRASEODYMIUM AFTER PARTIAL REPLACEMENT OF Fe^{3+} IONS BY Al^{3+} IONS.

K.P.Belov, M.A.Zaitseva and A.M.Kadomtseva.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 4(10), 1148-50 (Oct., 1960). In Russian.

The effect on the hysteresis curves of the two orthoferrites La_2O_3—Fe_2O_3 and Pr_2O_3—Fe_2O_3, caused by replacing some of the iron ions by aluminium ions was studied. The new ferrites thus obtained were La_2O_3—0.9 Fe_2O_3—0.1 Al_2O_3, and Pr_2O_3—0.9 Fe_2O_3—0.1 Al_2O_3. Hysteresis curves are shown for the two pairs of original and Al-substituted ferrites. One effect was to reduce the coercive force greatly. In the La case the whole hysteresis curve was shifted, increased in area, and made more symmetrical. In the Pr case, the area was reduced. Other graphs show the effects of heating and cooling on the intensity of magnetization, when the specimens were kept in a constant field of 4000 Oe.

N.Davy

1240 MEASUREMENT OF THE SATURATION MAGNETIZATION OF FERRITES BY FERROMAGNETIC RESONANCE. F.Schneider.

Z. angew. Phys. (Germany), Vol. 12, No. 10, 447-50 (Oct., 1960). In German.

The distance between the absorption lines (Walker modes) of polycrystalline NiZn ferrite spheres in an inhomogeneous microwave field is proportional to their saturation magnetization; values so obtained agree to within 3% with those measured with a magnetic balance.

E.P.Wohlfarth

1241 ON THE THEORY OF SPIN WAVES IN FERRIMAGNETICS. J.Kociński.

Acta phys. Polon. (Poland), Vol. 19, No. 5, 565-72 (1960).

An investigation is made of a ferrimagnetic with spins pointing in the same direction at absolute zero temperature. The models are simple cubic and body centered cubic lattices with two kinds of spins s, S, attached to the lattice points of two magnetic sublattices in such a way that a small spin s has as its nearest neighbours large spins S and vice versa. Spin waves are introduced in a manner analogous to that of Dyson for the ferromagnetic case. As in Dyson's theory, the Hamiltonian of the system is explicitly separated into a diagonal part representing the energy of free spin waves and a nondiagonal part determining the dynamical spin–wave interaction. A quadratic dispersion law with two frequency branches of spin-wave propagation is obtained.

1242 NEUTRON DIFFRACTION STUDIES OF CHROMIUM-MODIFIED Mn_2Sb.

W.H.Cloud, H.S.Jarrett, A.E.Austin and E.Adelson.

Phys. Rev. (USA), Vol. 120, No. 6, 1969-70 (Dec. 15, 1960).

Existence of a ferrimagnetic to antiferromagnetic phase transition with decreasing temperature in Mn_2Sb modified with 2.3 wt.% Cr is confirmed by neutron diffraction.

1243 MAGNETIC SUSCEPTIBILITY OF AN ANTIFERROMAGNETIC WHOSE MAGNETIC IONS FORM A F.C.C. LATTICE. A.Corciovei.

Stud. Cercetari Fiz. (Roumania), Vol. 9, No. 2, 203-14 (1958). In Roumanian.

By the spin waves method, in Holstein–Primakoff's formulation (1940), the magnetic properties at low temperatures of an antiferromagnetic, whose magnetic ions form a f.c.c. lattice and in which the exchange interactions are predominating, are examined. The consequences of considering the anisotropy term are pointed out, in accordance with some other results (Abstr. 1921 of 1951).

1244 ON THE MAGNETOELECTRIC EFFECT IN ANTIFERROMAGNETICS. D.N.Astrov.

Zh. eksper. teor. Fiz. (USSR), Vol. 38, No. 3, 984-5 (March, 1960). In Russian.

According to a theory by Landau and Lifschitz, there ought to be a linear relation between the internal magnetic and electric fields in certain crystals. If an electric (magnetic) field is applied, a magnetic (electric) field and moment ought to be called into being. This effect has been found in single crystals of Cr_2O_3 and measurements of the magnetic moment produced by applying an electric field have been made at various temperatures. A diagram of the apparatus and two graphs connecting magnetic moment and temperature, for electric fields of 230 and 430 volts/cm, are given.

N.Davy

1245 LATTICE STATISTICS IN A MAGNETIC FIELD. II. ORDER AND CORRELATIONS OF A TWO-DIMENSIONAL SUPER-EXCHANGE ANTIFERROMAGNET.

M.E.Fisher.

Proc. Roy. Soc. A.(GB), Vol. 256, 502-13 (July 19, 1960).

For Pt I, see Abstr. 10183 of 1960. The long-range order and pair correlation functions of a two-dimensional super-exchange antiferromagnet in an arbitrary magnetic field are derived rigorously from properties of the standard square Ising lattice in zero field. The model investigated was described in Pt I: it is a decorated square lattice with magnetic spins on the bonds coupled antiferromagnetically via non-magnetic spins on the vertices). The behaviour near the transition temperature in a finite field is similar to that of the normal plane lattice, i.e. the long-range orders or spontaneous magnetizations of the sublattices vanish as $(T_t-T)^{1/8}$ and the pair correlations behave as

$$\omega_c + W(T-T_t)\ln\left|T-T_t\right|.$$

The configurational entropy is discussed and the anomalous entropy in the critical field at zero temperature is calculated exactly.

ANTIFERROMAGNETIC ORDERING IN STACKING FAULTS. See Abstr. 912

1246 SUSCEPTIBILITY OF CHROMIUM-BASED ALLOYS OF TRANSITION ELEMENTS. W.M.Lomer.

Austral. J Phys., Vol. 13, No. 2a, 451-9 (July, 1960).

Solid State Physics Conference (see Abstr. 17864 of 1960). The magnetic properties of chromium-based alloys with the transition metals are very varied. Below room temperature it is believed that chromium is antiferromagnetic and this paper investigates briefly the nature of the influence of this antiferromagnetic matrix on the properties of dilute solutions of atoms carrying well-defined local moments of their own. It is shown that various anomalies in the susceptibility–temperature relations can be rationalized in terms of a model involving small spin orientation forces arising from the antiferromagnetism. Alloying with vanadium appears to reduce the spin moment on the chromium atoms, but to introduce no localized spins itself. The temperature-independent contributio of cobalt in solution is interpreted in terms of local spins locked by the antiferromagnetism of the matrix. The results so far obtained suggest that careful specific heat measurements in the range 0-100° K may disclose very significant anomalies in many of these alloys.

1247 ANTIFERROMAGNETISM IN $KMnF_3$. S.Ogawa.

J. Phys. Soc. Japan, Vol. 14, No. 8, 1115 (Aug., 1959).

Susceptibility measurements are reported for two samples, one prepared from aqueous solutions of potassium fluoride and manganese chloride, the other from melting these salts at 900° C in a platinum crucible. Both specimens obeyed a Curie–Weiss law abov about 100° K. Small but significant differences are quoted for the lattice parameters, Néel temperatures, Curie constants and effectiv Bohr magneton numbers of the two specimens.

R.Parke

1248 ON THE MAGNETIC PROPERTY OF IRON TELLURIDE I.Tsubokawa and S.Chiba.

J. Phys. Soc. Japan, Vol. 14, No. 8, 1120-1 (Aug., 1959).

The magnetic susceptibility of α-phase $FeTe_{0.95}$ shows a maximum at about 63° K, the temperature of the lamba point anomal reported by Westrum, Chou and Gronvold (Abstr. 6854 of 1959). Th susceptibility above the lambda temperature indicates an effective Bohr magneton number of 2.44. It is suggested that the compound becomes antiferromagnetic with a Néel temperature of 63° K.

A.J.Manu

1249 ANTIFERROMAGNETISM OF $Mn_{2.35}Ge$. K.Yasukōchi, T.Ohoyama and K.Kanematsu.

J. Phys. Soc. Japan, Vol. 14, No. 12, 1820 (Dec., 1959).

The material had a hexagonal close-packed structure with lattice constants a = 2.668 ± 0.003 A, and c = 4.309 ± 0.003 A. When the inverse susceptibility is plotted against temperature the Curie–Weiss law holds at higher temperatures but a minimum at 139° K may be considered as the antiferromagnetic Néel point.

C.A.Hogar

1250 SPIN-WAVE SPECTRUM OF YTTRIUM IRON GARNE R.L.Douglass.

Phys. Rev. (USA), Vol. 120, No. 5, 1612-14 (Dec. 1, 1960).

The spin-wave spectrum of YFe garnet is treated using a Hamiltonian involving nearest-neighbour a–a, d–d, and a–d isotopic exchange interactions. Values of the exchange constants are estimated from the molecular field constants of Pauthenet. Anisotropy and magnetic dipole–dipole interactions are neglected. Twenty spin-wave modes are found, and their energies calculated at points of cubic symmetry in k space. The dispersion relation of the single "acoustical" spin-wave mode is found to agree with the value previously reported by Meyer and Harris.

1251 NEUTRON DIFFRACTION INVESTIGATION OF MAGNETIC ORDERING IN THE TRIFLUORIDES OF 4d-TRANSITION ELEMENTS.

M.K.Wilkinson, E.O.Wollan, H.R.Child and J.W.Cable.

Phys. Rev. (USA), Vol. 121, No. 1, 74-7 (Jan. 1, 1961).

MoF_3 becomes antiferromagnetic below 185°K with a spin-only magnetic moment corresponding to $S = \frac{3}{2}$ and a magnetic structure which can be correlated with coupling rules applicable to the iron-group trifluorides. These results, together with the absence of observable magnetic neutron scattering from PdF_3 and RuF_3, sugge that Hund's rule does not apply to ions in the 4d-transition series.

Magnetic Resonances

1252 INTERNAL FERROMAGNETIC RESONANCE AND MAGNETOSTATIC MODES IN NICKEL–IRON ALLOYS

J.C.Anderson.

Proc. Phys. Soc. (GB), Vol. 76, Pt 2, 273-81 (Aug., 1960).

Experiments are described in which colloidal suspensions of kel—iron alloys in paraffin-wax were prepared for the purpose measuring, by internal ferromagnetic resonance, the total ernal magneto-crystalline anisotropy field as a function of alloy mposition. Determination of the internal resonance frequency s by measurement of the complex permeability of the particles er a range of frequencies. The variation of internal field with mposition was found to be in agreement with previous qualitative servations by Anderson and Donovan (1957) employing a different chnique and the total anisotropy was found to pass through a nimum in the region of 65% nickel. Values for the anisotropy nstants K_1 and K_2 were calculated from the results and were com- red with published values. Multiple peaks in the permeability ainst frequency curves were interpreted as magnetostatic reso- nce modes of different order as predicted by Walker (1957) from eoretical considerations.

1253 SINGLE CRYSTALS OF MAGNESIUM—MANGANESE FERRITES WITH A NARROW FERROMAGNETIC SONANCE ABSORPTION CURVE.

P.Belov, V.F.Belov and A.A.Popova.

. eksper. teor. Fiz. (USSR), Vol. 38, No. 6, 1908-10 (June, 1960). Russian.

While many recent researches have been devoted to the width of ferromagnetic resonance absorption line obtained with single ystals of the yttrium garnet type of ferrites, the present work in- lves magnesium—manganese ferrites, which belong to the spinel ass. Four such ferrites are studied. The narrowest line width tained is ΔH = 12 oersted, with a compound containing 8.4% MgO, .9% MnO and 67.5% Fe_2O_3. Graphs derived from a complete study the anisotropy of the line width in the case of single crystals of 9% MgO, 37.3% MnO and 55.9% Fe_2O_3 in various directions in the 10) plane are presented. Three graphs showing the effect of tem- rature changes on the line width, the saturation intensity, and the agnetic anisotropy constant are also included. [English translation : Soviet Physics—JETP (USA)]. N.Davy

1254 THE WALL EFFECT IN FERRIMAGNETIC RESONANCE EXPERIMENTS.

W.B.Nash and K.J.Standley.

oc. Phys. Soc. (GB), Vol. 76, Pt 1, 99-103 (July, 1960).

Measurements were made of the shift in the applied magnetic eld for resonance, caused by the presence of a conducting wall. nall spheres of nickel ferrite and magnesium manganese ferrite ere used at wavelengths of 0.87, 1.25 and 3.12 cm and of yttrium on garnet at a wavelength of 3.12 cm only. The shift was always lower fields and was independent of frequency within experi- ental error. Its magnitude at room temperature was 135 and 0 Oe in nickel and magnesium manganese ferrites, respectively. the garnet, the shift was found to be dependent upon the orien- tion of the steady field with respect to the conducting plane. A mple explanation is presented which gives agreement with the perimental data in order of magnitude.

1255 FERRIMAGNETIC RESONANCE LINE WIDTH IN POLY-CRYSTALLINE $Y_3Fe_{5-x}In_xO_{12}$.

Miyadai, Y.Shichijo and I.Tsubokawa.

Phys. Soc. Japan, Vol. 14, No. 6, 853 (June, 1959).

The line-width increases rapidly with x from 130 Oe for x = 0 a maximum of 900 Oe for x = 1.3, beyond which it decreases ightly. The absorption follows the changes in saturation magneti- tion, increasing slightly up to x = 0.3 and then decreasing to zero x = 2. The g-values were between 2.01 and 2.03. Tentative planations are given. D.J.Oliver

1256 ANTIFERROMAGNETIC RESONANCE IN $CoCl_2.6H_2O$.

M.Date.

Phys. Soc. Japan, Vol. 14, No. 9, 1244 (Sept., 1959).

Paramagnetic resonance was observed in a crystal of $Cl_2.6H_2O$ at 35 kMc/s at 4.2° K and the g-values along the incipal crystal directions are compared with those inferred om susceptibility measurements. Discrepancies are put down residual antiferromagnetic order. Pure antiferromagnetic re- nance was observed below 2.1° K and results of measurements e described in general terms. R.Parker

1257 APPLICATION OF MAGNETIC RESONANCE TECHNIQUES TO THE STUDY OF SEMICONDUCTOR RFACES.

G.K.Walters.

Phys. Chem. Solids (GB), Vol. 14, 43-50 (July, 1960).

After a brief discussion of the magnetic resonance phenomenon, perimental methods and sensitivity considerations, there follow sections on the application of electron and nuclear paramagnetic resonance techniques respectively to the study of solid surfaces. Attention is given to the pioneering work done in these fields. The various types of surface information which one might hope to obtain by resonance investigations are outlined, and some preliminary new experimental results are presented.

1258 ELECTRON SPIN RESONANCE IN NEUTRON-IRRADIATED CALCITE.

J.C.Kemp.

J. chem. Phys. (USA), Vol. 33, No. 4, 1269-70 (Oct., 1960).

Specimens of 900 mg each were given doses between 10^{17} and 10^{19} fast neutrons after which several set of electron spin resonance lines were observed. There were three groups of anisotropic spectra identical except for a rotation of the symmetry axes. The line width in the least irradiated sample was 0.12 gauss and for one of the spectra T_1 was 5 ± 2 sec at 1.5° K and 2 μsec at 77° K. The multiplicity of the lines in the spectrum does not appear to be due to either fine or hyperfine structure. It is not known what these spectra are due to, though the possibility of linear CO_2 groups is mentioned. J.M.Baker

1259 EFFECT OF THERMAL TREATMENT OF PARAMAGNETIC RESONANCE SPECTRA OF RARE EARTH IMPURITIES IN CALCIUM FLUORIDE.

E.Friedman and W.Low.

J. chem. Phys. (USA), Vol. 33, No. 4, 1275-6 (Oct., 1960).

Experiments were made on crystals containing gadolinium impurity which showed that one could transform the point symmetry about the paramagnetic ion from axial to cubic symmetry or vice versa with relative ease by the appropriate heat treatment. A crystal cooled slowly from 1200° C shows predominantly axial symmetry, and rapid cooling from 1200° C gives predominantly cubic symmetry. The amount of conversion from one symmetry to another is greater the longer the time spent at the high temperature and the higher the value of this temperature. These experiments indicate that the extra F^- ion is not tightly bound to the neighbourhood of the trivalent impurity, and that if the crystal is quenched the excess fluorine has no time to diffuse to the energetically more stable sites near the trivalent ion. J.M.Baker

1260 ELECTRON PARAMAGNETIC RESONANCE IN MANGANESE-DOPED FLUORSPAR.

B.Elschner.

"Optics of all wavelengths" Meeting, Jena, 1958 (see Abstr. 224 of 1961) p. 74-5. In German.

Results in agreement with those of Baker et al. (Abstr. 13455 of 1959) are obtained for the fine structures in calcium fluoride crystals containing 0.1 atom per cent of Mn^{2+}. In addition to splitting due to the nuclear spin of manganese, further fine structure occurs on account of exchange between the Mn^{2+} ions and the eight surrounding fluoride ions. Nine components due to the latter interaction are observed when the magnetic field is parallel to the cubic edge of the crystal. J.Sheridan

1261 ORIENTATION DEPENDENCE OF THE PARAMAGNETIC RESONANCE IN COPPER SULFATE $CuSO_4.5H_2O$.

W.Berger and H.J.Kössler.

Naturwissenschaften (Germany), Vol. 12, No. 18, 424-5 (1960). In German.

Reports direct measurements of the real and imaginary parts of the complex susceptibility as functions of the applied magnetic field for two crystallographic directions of the single crystal. Measuring techniques employed are to be reported later. The orientation dependence of the Lande g-factor is investigated and discussed in terms of the susceptibility measurements. P.M.Parker

1262 PARAMAGNETIC RESONANCE OF MANGANESE IN $KMgF_3$.

S.Ogawa and Y.Yokozawa.

J. Phys. Soc. Japan, Vol. 14, No. 8, 1116 (Aug., 1959).

Many lines in addition to the usual fine and hyperfine structure lines for Mn^{2+} ions have been observed for a concentration of the order of 10^{-4} of Mn ions in $KMgF_3$. They may be described by a spin Hamiltonian containing a term arising from interaction of the six nearest neighbour fluorine nuclei with the manganese spin. The results are in agreement with deductions from F^{19} nuclear resonance in $KMnF_3$ [Schulman, Knox and Wyluda, Bulletin of the American Physical Society, Vol. 4, 166 (1959)]. A.J.Manuel

1263 ELECTRON PARAMAGNETIC RESONANCE OF MANGANESE IN TiO_2.

H.G.Andresen.

Phys. Rev. (USA), Vol. 120, No. 5, 1606-11 (Dec. 1, 1960).

The paramagnetic resonance spectrum of a manganese-doped single crystal of TiO_2 in its rutile structure was investigated at a frequency of 9.505 kMc/s at room temperature. The following results were obtained. The manganese atoms replace the Ti^{4+} ions in the rutile and exist as tetravalent ions having a spin value of $S = \frac{3}{2}$ and strong admixtures of covalent bonds to their six oxygen neighbours. The parameters of the spin Hamiltonian were determined to be $g = 1.990$, $D = 12.1$ kMc/s, and $|E| = 0.388$ kMc/s. Within the accuracy of this experiment the magnetic hyperfine structure was isotropic and could be described by $|A| = 215$ Mc/s.

1264 ELECTRON PARAMAGNETIC RESONANCE OF VANADIUM IN RUTILE.

G.M.Zverev and A.M.Prokhorov.
Zh. eksper. teor. Fiz. (USSR), Vol. 39, No. 1(7), 222-3 (1960).
In Russian.

The electron paramagnetic resonance spectrum of vanadium (0.01%) in rutile (TiO_2) has two components each with the expected ($I = \frac{7}{2}$) hyperfine structure corresponding to the two non-equivalent sites in the rutile lattice. The angular dependence gives the anisotropic g factor and hyperfine interaction constant which are quoted and are the same at 9800 and 37 500 Mc/s. The results are like those for Cr^{3+} in rutile and confirm that the paramagnetic entity is V^{4+}. T_1 measured by saturation is 0.2 sec at 4.2°K and 6×10^{-6} sec at 90°K, but this does not give a satisfactory explanation of the line widths and is being further investigated. [English translation in: Soviet Physics—JETP (USA)]. J.G.Powles

1265 SPIN—LATTICE RELAXATION TIMES IN RUBY AT 34.6 Gc/s. J.H.Page, D.F.Sampson and J.S.Thorp.

Proc. Phys. Soc. (GB), Vol. 76, Pt 5, 697-704 (Nov., 1960).

Measurements of spin—lattice relaxation time in ruby were made at 34.6 Gc/s by a pulse saturation method at temperatures from 1.4° to 90°K. With weak Cr concentrations the values for the first-order transitions (e.g. 22 msec at 4.2°K) were of the same order of magnitude as those reported at lower frequencies, and the variation of relaxation time with temperature was in fair agreement with theory. A successive increase in relaxation time with the order of the transition, pronounced at 1.4°K, decreased with increasing temperature, and at about 77°K a common value of about 44 μsec was obtained for all transitions. The main effects of increasing Cr concentration were to reduce the relaxation time and alter its temperature dependence.

1266 PARAMAGNETIC RESONANCE ABSORPTION FROM ACCEPTORS IN SILICON.

G.Feher, J.C.Hensel and E.A.Gere.
Phys. Rev. Letters (USA), Vol. 5, No. 7, 309-11 (Oct. 1, 1960).

Reports the observation of the paramagnetic resonance signal from p-type silicon subjected to a uniaxial stress, which removes the degeneracy of the valence band and thereby eliminates the difficulties encountered in previous attempts to observe the paramagnetic resonance from acceptors. Results are given for four different acceptors subjected to stresses of 700-900 kg/cm^3. J.M.Baker

1267 NEW ELECTRON SPIN RESONANCE SPECTRUM IN ANTIMONY-DOPED GERMANIUM.

R.E.Pontinen and T.M.Sanders, Jr.
Phys. Rev. Letters (USA), Vol. 5, No. 7, 311-13 (Oct. 1, 1960).

The observation of an apparently new electron spin resonance spectrum in antimony-doped germanium in the helium temperature range is reported. The spectrum consists of four lines each with an anisotropic g-factor, with axial symmetry about the [111] directions. The principal values of the g-tensor are $g_{\parallel} = 0.820 \pm \pm 0.008$ and $g_{\perp} = 1.922 \pm 0.007$. The details of the spectrum are described and several possible mechanisms which might be responsible for the spectra are discussed. However, none of the models seems to be consistent with all of the data. J.M.Baker

1268 MAGNETIC RESONANCE IN SODIUM ALLOYS.

N.S.Garif'yanov and A.V.Il'yasov.
Fiz. Metallov i Metallovedenie (USSR), Vol. 9, No. 4, 503-6 (April, 1960). In Russian.

The paramagnetic resonance of conduction electrons in Na—Cs alloys, containing up to 1.0 at.% Cs, was measured at 90 and 295°K and 300 and 9430 Mc/s, and the concentration dependence of the "Knight shift" of lines of the Na^{23} nuclear-magnetic resonance in Na—K, Na—Cs, and Na—Hg alloys was studied. It was concluded that, in contrast to the alloying additions with strong spin-orbital interaction, those in which the spin-orbital interaction is weak (alkali metals) can have a pronounced effect on the frequency of the nuclear-magnetic resonance. M.H.Sloboda

1269 HYPERFINE STRUCTURE OF F-CENTER SPIN RESONANCE IN SODIUM AZIDE.

F.F.Carlson, G.J.King and B.S.Miller.
J. chem Phys. (USA), Vol. 33, No. 4, 1266-7 (Oct., 1960).

Microcrystalline NaN_3 was irradiated with u.v. light at 90°K and an e.s.r. spectrum of 19 evenly spaced lines near $g = 2$ was observed. It is suggested that this spectrum is due to an N^{3-} vacancy, and that the structure is due to hyperfine interaction with the six nearest-neighbour sodium nuclei. J.M.Bak

1270 PULSED FIELD MEASUREMENTS OF LARGE ZERO-FIELD SPLITTINGS : V^{3+} IN Al_2O_3.

S.Foner and W.Low.
Phys. Rev. (USA), Vol. 120, No. 5, 1585-8 (Dec. 1, 1960).

Use of pulsed magnetic fields for determining large zero-field splittings of paramagnetic ions is considered. Measurements of zero-field splittings of over 50 cm^{-1} are feasible; a numerical example for $S = 1$ is discussed in order to indicate the present range and limitations of the method. The method is applied to measurements of the zero-field splitting of V^{3+} in Al_2O_3 at 4.2° and 1.5°K. Assuming $g_{\parallel} = 1.92$, $D = 7.85$ cm^{-1} was determined from experiments with 4 mm and 8 mm wavelength radiation and pulsed magnetic fields of the order of 100 kG. The magnitude and sign of D are in good agreement with earlier estimates from optical and microwave measurements.

1271 THE INFLUENCE OF THE EXTERNAL [MAGNETIC] FIELD ON THE [E.S.R.] LINE WIDTH OF POWDERED DPPH. You Hing Tchao.

C.R. Acad. Sci. (France), Vol. 251, No. 5, 668-70 (Aug. 1, 1960).
In French.

Measurements were made between 12 and 33 500 Mc/s. At the latter frequency, the line width is 7.1 Oe and it extrapolates to a value of 2.1 ± 0.1 Oe at zero frequency. The variation follows closely the relation

$$\Delta H - \Delta H_0 = \chi_d H/Nr^3,$$

with $r = 0.94$ a. The latter term is due to the anisotropic diamagnetism of the benzene rings. J.M.Bake

1272 THE INFLUENCE OF THE STRUCTURE OF AN ELECTRON SPIN RESONANCE LINE ON THE DYNAMIC POLARIZATION OF NUCLEI.

J.L.Motchane and J.Uebersfeld.
C.R. Acad. Sci. (France), Vol. 251, No. 5, 709-11 (Aug. 1, 1960).
In French.

The dynamic nuclear polarization in paramagnetic solids, whos electronic resonance is inhomogeneous, is studied theoretically as a function of saturating field. The paramagnetic centres are suppose to be sufficiently numerous so that the effects of diffusion may be neglected. The inhomogeneous character of the e.s.r. line affects dependence of the nuclear polarization upon saturating field; the polarization is also dependent upon the relative values of the nuclea resonance frequency and the half-width of the e.s.r. line.

J.M.Bak

1273 RESONANT SPIN—SPIN INTERACTION BETWEEN DONORS AND ACCEPTORS IN SILICON. R.A.Levy.

Phys. Rev. Letters (USA), Vol. 5, No. 9, 425-7 (Nov. 1, 1960).

Experiments on the decay of magnetization are reported for strained and unstrained samples of compensated silicon after populating donor and acceptor states with optical radiation at liquid helium temperatures. A reduction of the direct relaxation time of donor electrons was found and is attributed to a resonant spin—spi interaction with a background acceptor resonant line.

P.T.Landsber

1274 THE OVERHAUSER EFFECT IN METALS CONTAININ PARAMAGNETIC IMPURITIES. L.L.Buishvili.

Fiz. tverdogo Tela (USSR), Vol. 2, No. 9, 2268-9 (Sept., 1960).
In Russian.

The author considers the polarization of nuclei of paramagneti ions in a metal containing paramagnetic impurities and derives an expression which extends Overhauser's result to alloys. [English translation in: Soviet Physics—Solid State (USA)].

M.G.Priestley

1275 HIGHER ORDER TRANSITIONS IN DOUBLE RESONAN K.Sugihara.

J. Phys. Soc. Japan, Vol. 14, No. 8, 1054-63 (Aug., 1959).

A theory is given to explain the results of double resonance xperiments in metal halides (Abstr. 8357 of 1959) and in caesium romide (Abstr. 4389 of 1958). The theory depends on carrying out perturbation calculation to higher order than is usually necessary.

J.G.Powles

1276 NUCLEAR MAGNETIC RESONANCE IN A THREE-NUCLEI-SYSTEM.

A.Corciovei and M.Mugur.

tud. Cercetari Fiz. (Roumania), Vol. 8, No. 3, 267-94 (1957). Roumanian.

A three-nuclei-system, each nucleus with a $\hbar/s$ spin, the ositions of which are parametrically given by their position ectors, was considered. By studying the stationary states, the nergy levels of the system, in a constant magnetic field $\mathcal{H}_0$, were etermined. The Van Vleck Hamiltonian of the system was divided nto two terms: (1) the fundamental Hamiltonian H^0, including eeman's term and that part of the dipolar term that contains the lements for which $\Delta S_Z = 0$ (where S_Z is the magnetic quantic total pinning number); (2) the perturbation Hamiltonian H^1, containing e remainder of the dipolar term elements and the exchange term. this way, the level values are obtained more accurately than in revious work. The transition probabilities in a weak oscillating agnetic field, normal to $\mathcal{H}_0$ were also determined. For the ransitions $\Delta S_Z = \pm 1$, three other groups of very low intensity were und, in addition to the four groups' lines of high intensity. It is lso shown that the lines for which $\Delta S_Z = 0, \pm 2$ are not absolutely rbidden, as some authors had established, though they are of a low tensity, of about $(D/Z)^2$ with regard to the high intensity lines.

1277 MAGNITUDE AND SIGN OF THE CONDUCTION ELECTRON POLARIZATION IN RARE-EARTH METALS.

.Jaccarino, B.T.Matthias, M.Peter, H.Suhl and J.H.Wernick.

hys. Rev. Letters (USA), Vol. 5, No. 6, 251-3 (Sept. 15, 1960).

The magnitude and sign of the conduction electron polarization XAl_2 intermetallic compounds (where X = La, Ce, Pr, Nd, Sm, u, Gd, Tb, Dy, Ho, Er, Tm, Yb, Lu and U) were determined by .m.r. techniques as a function of magnetic field in the temperature ange 4.2-300° K; and in $EuAl_2$ and $GdAl_2$ by e.s.r. at 55 kMc/s in e temperature range 100-300° K. Large temperature dependent night shifts were observed for the series XAl_2 from X = Ce to m and for UAl_2. The results are discussed in considerable detail, nd interpreted in terms of a negative exchange interaction of 0.1 eV between the localized f-electrons and the conduction elecrons.

S.A.Ahern

1278 THE LONGITUDINAL RELAXATION OF NUCLEAR SPINS AT VERY LOW TEMPERATURES IN A PARA-AGNETIC CRYSTAL.

B.I.Kochelaev.

h. eksper. teor. Fiz. (USSR), Vol. 38, No. 3, 999-1000 (March, 960). In Russian.

A one-page summary of mathematical calculations leading to expression for the probability of a nuclear relaxation transition, ring which one Bose particle is created and another of different ergy disappears. Experiments on the protons in the water of rystallisation in a paramagnetic crystal of cerium magnesium trate at a temperature of 0.086° K do not measure the time of laxation exactly, but show that its upper limit is 32 seconds. nglish translation in: - Soviet Physics —JETP (USA), Vol. 11, o. 3, 719-20 (Sept., 1960)].

N.Davy

1279 THE INFLUENCE OF THE TUNNEL TRANSITION ON THE FORM OF THE LINE SIGNAL OF NUCLEAR AGNETIC RESONANCE IN CRYSTALS.

I.V.Aleksandrov.

okl. Akad. Nauk SSSR, Vol. 133, No. 5, 1057-9 (Aug. 11, 1960). Russian.

A quantum mechanical treatment of the line shape in nuclear agnetic resonance is carried out for the case of a pair of nuclei eorientated by a tunnelling mechanism. The case of weak magnetic bstances is considered so that the interaction of the nuclei with e remainder of the specimen may be neglected and the spin—ttice relaxation time is large. The special case of the very fast ansition and that when no interchange occurs is included. [English anslation in: Soviet Physics—Doklady (USA)].

K.N.R.Taylor

1280 NUCLEAR MAGNETIC RESONANCE SPECTRUM OF Co^{59} IN METALLIC COBALT POWDERS.

.Street, D.S.Rodbell and W.L.Roth.

hys. Rev. (USA), Vol. 121, No. 1, 84-6 (Jan. 1, 1961).

The spectrum contains three lines in addition to the already ell-known line of Co^{59} in face-centred cubic cobalt (213.1 Mc/s at ° C). The other lines are higher in frequency, the highest located 10.0 Mc/s above the f.c.c. resonance and is much less intense than the f.c.c. This highest lying resonance is identified to be due to Co^{59} nuclei in hexagonal close-packed cobalt, and the lower intensity is qualitatively accounted for by examining the effect on the resonance of the nuclear quadrupole moment in a noncubic environment.

1281 NUCLEAR MAGNETIC RESONANCE OF Ni^{61} IN METALLIC NICKEL.

L.J.Bruner, J.I.Budnick and R.J.Blume.

Phys. Rev. (USA), Vol. 121, No. 1, 83 (Jan. 1, 1961).

The resonance was observed in unenriched metallic nickel. The results provide the first experimental measure of the internal field at the nucleus in nickel. The resonance occurs at a frequency of 26.02 Mc/s at room temperature, yielding an estimate of 170 kG for the internal field.

1282 NUCLEAR MAGNETIC RESONANCE AND MAGNETIC ORDERING IN NiF_2.

R.G.Shulman.

Phys. Rev. (USA), Vol. 121, No. 1, 125-43 (Jan. 1, 1961).

Measurements of the nuclear magnetic resonance of the F^{19} nucleus in single crystals of NiF_2 were made at temperatures between 4.2° and 298° K. In the paramagnetic state at 298° K, for arbitrary directions of H_0 two resonances were observed, while for H_0 in a (100) plane only one resonance was observed as expected from the crystal symmetry. The shift of the resonances from the normal resonance field ω/γ_N allows one to calculate three independent parameters of the hyperfine interaction between the F^{19} nuclei and the magnetic electrons. In conjunction with measurements made in the antiferromagnetic state, it was possible to determine the individual components of the hyperfine interaction in units of 10^{-4} cm^{-1} as $A_s{}^I = 36.4 \pm 1.8$, $A_s{}^{II} = 42.1 \pm 2.1$, $A_\sigma{}^I = 9.1 \pm 0.9$, and $A_\sigma{}^{II} = 9.9 \pm 0.9$. Superscripts refer to the two different bonds with Ni^{2+} and subscripts s and σ refer to isotropic and anisotropic contributions. From these it is calculated that the fractions of unpaired spin in the corresponding fluoride ions s and p_σ orbitals are $f_s{}^I = (0.46 \pm 0.02)\%$, $f_s{}^{II} = (0.54 \pm 0.03)\%$, $f_\sigma{}^I = (4.1 \pm 0.4)\%$, and $f_\sigma{}^{II} = (4.5 \pm 0.4)\%$. Since geometrical considerations almost completely forbid magnetic p_π interactions in NiF_2, there is a negligible cancellation of p_σ interactions by the p_π so that, unlike the case for MnF_2 and FeF_2, the admixture of magnetic electrons into fluoride ion orbitals is almost completely determined. At temperatures just above the antiferromagnetic transition $T_N = 73.2°$ K, the resonance shifts with H_0 in the (001) plane change rapidly with temperature. Between 75.7° K and T_N the susceptibility of one sublattice becomes negative while the other remains positive. This is correlated with the sublattice susceptibility derived by Moriya (Abstr. 4502 of 1960) from the spin Hamiltonian $\mathcal{H} = g\beta H + DS_z{}^2 + E(S_x{}^2 - S_y{}^2)$. By fitting the theoretical susceptibility the author determined the sign of E in this Hamiltonian. Below 73.2° the nuclear resonances are consistent with Moriya's model in which the spins are antiparallel along [100] and tipped ~1.3° towards [010]. Ericson's description (Abstr. 6132 of 1953) of the magnetic ordering is shown to be incorrect. In the antiferromagnetic state the F^{19} resonance broadens as H_0 is lowered below 5000 G.

NUCLEAR MAGNETIC RESONANCE OF Ta^{181} IN $KTaO_3$: NUCLEAR MOMENT DETERMINATION. See Abstr. 597

THALLIUM NUCLEAR RESONANCE SPECTRA. See Abstr. 155

1283 EFFECTIVE MASS IN GRAY TIN FROM KNIGHT SHIFT MEASUREMENTS.

W.E.Blumberg and J.Eisinger.

Phys. Rev. (USA), Vol. 120, No. 6, 1965-8 (Dec. 15, 1960).

The nuclear magnetic resonance of Sn^{119} in grey tin was measured between 200° and 300° K and the effective g-factor was found to increase by about 4 parts in 10^5 over this temperature range. This increase in Knight shift is thought to arise from an increase in the number of conduction electrons. By combining this result with Busch and Mooser's measurements of the magnetic susceptibility over the same temperature range m_l, the single-valley effective mass of the lighter of the charge carriers is found to be (0.3 ± 0.05) m if the electron g-factor is 2. The experiment also allows one to determine the Knight shift without making a comparison with a diamagnetic substance. The Knight shift of intrinsic grey tin is found to be 6×10^{-5} at 300° K. The fact that the Knight shift is positive shows that the electron g-factor is not negative as would be expected if the band structure of grey tin were similar to that of InSb.

1284 NUCLEAR SPIN–LATTICE RELAXATION IN VANADIUM METAL. J.Butterworth.
Phys. Rev. Letters (USA), Vol. 5, No. 7, 305-6 (Oct. 1, 1960).

The results show a much larger departure from the Korringa relation than has previously been observed: T_1T is constant = = 0.788 ± 1% sec°K. The Knight shift ranges from 0.55 to 0.58% which is 2-5 times the value calculated with the above value of T_1T. This increase in the value of the spin susceptibility of the s-electrons is probably due to an exchange interaction which also seems to account for the measured increases in the susceptibility of the d-electrons over the calculated value. The proportion of electrons at the Fermi surface having s character is estimated at 0.17.
D.J.Oliver

1285 PROTON MAGNETIC RESONANCE IN AZURITE $[Cu_3(CO_3)_2(OH)]$. W.van der Lugt and N.J.Poulis.
Physica (Netherlands), Vol. 25, No. 12, 1313-20 (Dec., 1959).

The experiments were performed on a single crystal, in the liquid hydrogen and liquid helium temperature ranges, for different field strengths and orientations. Two zero field resonance lines exist in the antiferromagnetic state. An antiferromagnetic electronic spin arrangement is proposed to explain the resonance diagrams. No threshold field was found for fields up to 9000 Oe. The magnetization in the antiferromagnetic state was measured as a function of temperature.

1286 ELECTRIC QUADRUPOLE INTERACTION OF Al^{27} AND POSITIVE ION DISTRIBUTION IN SPINEL $(MgAl_2O_4)$.
E.Brun, S.Hafner, P.Hartmann and F.Laves.
Naturwissenschaften (Germany), Vol. 47, No. 12, 277 (1960).
In German.

Nuclear quadrupole resonance interaction of Al^{27} in spinel is used as a probe to determine the relative distribution of Mg^{2+} and Al^{3+} in sites of tetragonal and octahedral symmetry. It is found that for naturally occurring spinel single crystals, Al predominantly occupies octahedral sites. For synthetic crystals, Al and Mg are predominantly randomly distributed over octahedral and tetragonal sites. Heating of the natural crystal produces the random distribution at temperatures between 800° and 900°C. P.M.Parker

1287 DISTORTION OF THE OCTAHEDRAL CHARGE DISTRIBUTION IN SOME COBALT COMPLEXES.
T.Sugawara.
J. Phys. Soc. Japan, Vol. 14, No. 6, 858 (June 1959).

The quadrupole effect on the nuclear resonance of Co^{59} in $K_3[Co(CN)_6]$ and $[Co(NH_3)_6]Cl_3$ was examined. The results provide evidence of an assymmetry in the charge distribution around the Co nucleus which is related to the anisotropy of the crystal field in paramagnetic compounds such as $Cr(NH_3)_6$ Cl and $K_3[Fe(CN)_6]$.
D.J.Oliver

1288 TEMPERATURE DEPENDENCE OF THE NUCLEAR QUADRUPOLE SPECTRUM OF Nb^{93} IN FERROELECTRIC $KNbO_3$. R.R.Hewitt.
Phys. Rev. (USA), Vol. 121, No. 1, 45-52 (Jan. 1, 1961).

The nuclear electric quadrupole interaction of Nb^{93} in ferroelectric $KNbO_3$ was measured as a function of temperature in the tetragonal, orthorhombic and rhombohedral phases. The values of $(1/\nu)(d\nu/dT)$ for these three phases are approximately -10^{-3}, -10^{-3}, and -10^{-4} per degree centigrade, respectively. In the tetragonal phase at 220° C, e^2qQ/h was measured as 24 Mc/s and the asymmetry parameter η is zero. An ionic calculation of field gradients in the tetragonal phase was made including point charge and induced dipole contributions. The results of this calculation give the Sternheimer antishielding factor $(1-\gamma_\infty)$ as 15, in good agreement with its estimated value of +16. The temperature dependence of the electric field gradient at the Nb^{93} site as calculated from this ionic model is in agreement with the measured temperature dependence in the tetragonal phase.

MECHANICAL PROPERTIES OF SOLIDS

1289 ELASTIC CONSTANTS OF COPPER-NICKEL ALLOYS. R.E.Schmunk and C.S.Smith.
Acta metallurgica (Internat.), Vol. 8, No. 6, 396-401 (June, 1960).

The elastic constants of single crystals of copper and of dilute alloys of copper with nickel have been measured using the ultrasoni pulse-echo technique. All fundamental elastic constants increase with composition in contrast to results previously obtained for solu to the right of copper in the periodic table. In terms of C_0^{-1} (dC/dx) the values are: C_{44}, (0.57); $(C_{11} - C_{12})/2$, (0.70); $(C_{11} + 2C_{12})/3$, (0.17) per atom fraction. These values have been corrected for lattice parameter change upon alloying by using exper mental data on the pressure derivatives of the elastic constants of pure copper. The remaining effect is owing to alloying alone and is still positive for both shear constants. This result may be interpre as indicating a stiffening of the short-range crystal forces because the neutral nickel ion-core is larger than the iso-electronic copper ion-core, and a decrease in the long-range electrostatic forces because of the decrease in the average ion-core charge.

1290 CORRECTED VALUES OF THE ELASTIC MODULI OF SAPPHIRE. W.G.Mayer and E.A.Hiedemann.
J. Acoust. Soc. Amer., Vol. 32, No. 12, 1699-1700 (Dec., 1960).

Corrected values are given based on earlier work of the authors but using more accurate crystal orientations.

1291 STATIC AND DYNAMIC ELASTIC CONSTANTS. L.Gold.
Brit. J. appl. Phys., Vol. 11, No. 11, 522-3 (Nov., 1960).

Measurements on ice show differences between the static and dynamic values of Young's modulus and Poisson's ratio. Over the range 0 to −40° C, the static value of Y perpendicular to the c-axis of the single crystal is only slightly dependent on temperature whereas that perpendicular to the grain boundaries of columna multigrained ice depends markedly on temperature. The sonic values of Y lie between 9 and 10 × 10^{10} dyn/cm^2 compared with the static values for the single crystal of 8.34 × 10^{10} and for multi grained ice of $(5.69 - 6.48 \times 10^{-2} T) \times 10^{10}$ where T is the tempera ture in °C. The sonic value for σ is about 0.32 compared with the static value of 0.42. These results are discussed and it is suggeste that two processes are concerned in the deformation of ice: this would upset the usual relationships between the elastic moduli for different conditions of stress. H.J.H.Star

1292 ADIABATIC ELASTIC MODULI OF COBALT-BONDED TUNGSTEN CARBIDES. F.F.Voronov and D.B.Balash
Fiz. Metallov i Metallovedenie (USSR), Vol. 9, No. 4, 616-20 (April, 1960). In Russian.

From the experimental data on the velocity of transverse and longitudinal ultrasonic waves in Co-bonded WC of known density, th adiabatic elastic modulus, E, volumetric modulus, K, shear modulus, G, and Poisson's ratio, σ, were determined. The values obtained for specimens containing 6% Co were $E = 6.2 \times 10^{12}$ dynes/c $K = 3.59 \times 10^{12}$ dynes/cm^2, $G = 2.61 \times 10^{12}$ dynes/cm^2, and $\sigma = 0.212$. On raising the Co content to 13%, E, K, and G decreased by 14.5, 14.7, and 12.6% respectively, and σ increased to 0.222.
M.H.Slobod

1293 ELASTIC CONSTANTS OF β TIN FROM 4.2° K TO 300° K. J.A.Rayne and B.S.Chandrasekhar.
Phys. Rev. (USA), Vol. 120, No. 5, 1658-63 (Dec. 1, 1960).

The adiabatic elastic constants were measured using the ultrasonic pulse technique. An unusually large variation with temperature of the shear constant $\frac{1}{2}(c_{11}-c_{12})$ was observed. From the elastic constants extrapolated to 0° K, the limiting value of the Deb temperature of tin was calculated. Using this value, the low-temperature specific heat data on both normal and superconducting tin were re-evaluated.

1294 ELASTIC CONSTANTS OF CsBr FROM 4.2° K TO 300° B.J.Marshall.
Phys. Rev. (USA), Vol. 121, No. 1, 72-3 (Jan. 1, 1961).

Measurements were made on single crystals. The values of th elastic constants at 4.2° K are $c_{11} = 3.350 \pm 0.8\%$, $c_{12} = 1.025 \pm 10\%$ and $c_{44} = 1.002 \pm 0.8\%$ in units of 10^{11} dynes/cm^2. The Debye temperature (θ_0) at 0° K as calculated from the elastic constants is 149.0° K ± 2° K. The lattice energy at 0° K is computed to be $U_0 = 147.6$ kcal/mole.

1295 THE DYNAMIC COMPRESSIBILITY OF HIGHPOLYME IN THE FREQUENCY RANGE FROM 0.1 c/s TO 60 kc/
P.Heydemann.
Acustica (Internat.), Vol. 9, No. 6, 446-52 (1959).

Several methods for the determination of the dynamic compressibility in the frequency range from 0.1 c/s to 60 kc/s were used to obtain compressibility data of 42 different high polymers.

e principle of the method which was mainly used is the following. ere is a small cylindrical cavity (5 cm^3) inside a rigid steel ock. In the front surfaces of this cavity barium titanate disks e embedded in plastic resin. The rest of the cavity is filled with e sample under test and a suitable confining liquid. An alter- ting voltage connected to one of the transducers causes volume anges of the barium titanate disk which in turn produce a certain essure in the chamber. This pressure is proportional to the input ltage and inversely proportional to the compressibility of the ling of the chamber. The pressure can be measured with the cond barium titanate transducer. A very simple equation results r the relation between input and output voltage and the compressi- lity of the sample. Results of the measurements on various poly- ers are given. It is shown that in the great majority of cases the mpressibility is constant within the measuring accuracy of 1% er the given frequency range. A distinct dispersion was only found r secondary cellulose acetate. It is further shown that for poly- ethyl methacrylate the calculation of one elastic constant from the o others in a frequency range where Young's modulus and shear odulus show dispersion leads to results that are in contrast to the easurements.

1296 DATA FROM VIBRATION EXPERIMENTS ON THE TECHNICAL BEHAVIOUR OF PLASTICS IN THE CASE F TRANSIENT (SHOCK) STRESSES. L.Bohn and H.Oberst.

custica (Internat), Vol. 9, 191-9 (1959), [= Akust. Beihefte, No. 1, 959)]. In German.

It is shown how the measured curves of Young's modulus and s loss factor versus temperature for a series of frequencies allow onclusions to be drawn as to the behaviour of plastics under shock ad (shock bending). Experimental results obtained with polypro- ylene and polytrifluorchlorethylene agree with and illustrate the eoretical considerations.

1297 THE EFFECT OF AGEING ON YOUNG'S MODULUS, ELECTRICAL RESISTIVITY, AND HARDNESS OF) : 20 MANGANESE—COPPER ALLOY. H.J.Stokes and I.D.Hewin.

Inst. Metals (GB), Vol. 89, Pt 2, 77-9 (Oct., 1960).

A detailed investigation has been made of the variation with mperature of Young's modulus for this alloy after ageing at tem- eratures between 400° and 600° C and for times between 0 and 00 min. Room temperature resistivity and hardness determinations so display a dependence upon ageing time and temperature. A inimum in the modulus/temperature relationship is moved to gher temperatures during ageing and the extent of the anomaly de- eases. By overageing it would appear possible to produce mater- l possessing a sensibly constant modulus over a range of almost 0° C.

1298 VARIATION OF YOUNG'S MODULUS OF FUSED QUARTZ FIBRE WITH DIAMETER. D.J.Tritton.

il. Mag. (GB) (Eighth Ser.), Vol. 4, 780-3 (June, 1959).

The values of Young's modulus for three fibres were determined om the resonant frequencies in flexural oscillation. The values tained were approximately (8, 7, and 6) × 10^{11} dynes/cm^2 for fibres diameter 20, 45 and 75 μ respectively. D.G.Holloway

1299 THE ΔE EFFECT IN IRON—NICKEL ALLOYS. M.Yamamoto.

ci. Rep. Res. Insts Tohoku Univ. A (Japan), Vol. 11, No. 2, 102-19 April, 1959).

The ΔE effect has been measured by the method of magneto- trictive vibration with annealed iron—nickel alloys covering the hole composition range. The density, ferromagnetic properties, nd Young's modulus were also determined. It has been found that oung's moduli of α phase (body-centred cubic) alloys containing ss than about 30% nickel are not affected by weak magnetic fields p to several oersteds. The ΔE effect in iron and 60 ~ 80% Ni alloys hows a small negative minimum at the field strength where the total r differential magnetic susceptibility becomes maximum. The ΔE ffect preceding saturation shows a secondary, somewhat onspicuous, increase in iron, 80% Ni alloy, and nickel and a slight ecrease in 5, 30, and 90% Ni alloys. The saturation values of the E effect have been found to be positive over the whole composition ange of the alloy system, as in expected theoretically, although the revious investigators gave negative saturation values for some of on-rich alloys. The magnitude of the saturation ΔE effect is at ost 0.3% in α phase alloys, while generally of the order of several ercent in γ phase (face-centred cubic) alloys containing more than bout 30% Ni. It is also shown that, with increasing nickel content, e density rises while Young's modulus falls in the α phase region, nd the former again rises hyperbolically but the latter shows a minimum value at about 40% Ni and a maximum value at about 85% Ni in the γ phase region.

1300 ROLLING STRUCTURE AND ELASTIC ANISOTROPY OF COLD-ROLLED α BRASS. O.Izumi.

Sci. Rep. Res. Insts Tohoku Univ. A (Japan), Vol. 11, No. 5, 375-82 (Oct., 1959).

The change in the elasticity of 70/30 brass with rolling reduction was measured in three directions; parallel, diagonal, and transverse to the rolling direction. The whole reduction range up to 90% was divided into three stages, according to the types of the anisotropy. At low reductions up to about 40%, one of the three directions, the parallel direction gave the maximum elasticity value, showing a peak at the reduction of 20~30%. Especially in a coarse-grained material, this change seemed to be due to a geometrical inhomogeneity of strain distribution found at the grain boundaries or at the band-shape regions existing along the rolling direction rather than to a crystallographic directionality. At high reductions beyond 70%, the developments of the rolling texture and flaw-like strain markings resulted in a high elasticity value in the transverse direction, and a low one in the other two. The intermediate reduction might probably show a stage transitional from one to the other mentioned above. The abnormal work-hardening previously pointed out by others was also discussed in relation to the present results.

1301 INTERNAL FRICTION AT THE GRAIN BOUNDARIES IN ALUMINIUM. A.V.Grin'.

Fiz. Metallov i Metallovedenie (USSR), Vol. 9, No. 4, 613-15 (April, 1960). In Russian.

The temperature dependence of internal friction was determined for three grades of Al, 99.994% Al representing the purest material. With increasing impurity content the magnitude of the internal friction peak increased, its position was shifted towards higher temperature, and the activation energy for internal friction increased. The effects observed were attributed to preferential adsorption of impurities at the grain-boundaries. M.H.Sloboda

1302 THE DEPENDENCE OF INTERNAL FRICTION ON FREQUENCY. J.Wilks.

Phil. Mag. (GB) (Eighth Ser.), Vol. 4, 1379-82 (Dec., 1959).

Using a model in which internal friction arises from a viscous-like damping of lengths of dislocation, anchored at each end by some form of pinning point, and vibrating with the applied stress, it can be shown that the damping should be proportional to the frequency of the oscillations. It appears, however, that in many metals the friction varies much more slowly than the first power of the frequency. The author indicates that a simple explanation of this behaviour is implied in a recent treatment by Thompson and Holmes (Abstr. 7550 of 1959). R.Bullough

1303 INTERNAL FRICTION IN GERMANIUM AND SILICON. I. ELECTRON AND IMPURITY RELAXATION.

P.D.Southgate.

Proc. Phys. Soc. (GB), Vol. 76, Pt 3, 385-97 (Sept. 1, 1960).

The internal friction of single-crystal silicon and germanium at 100 kc/s showed a relaxation peak near 0.56 of the melting temperature. The peak was electronic in origin and the relaxation time was the carrier lifetime. At the peak temperature, in many of the specimens measured, intrinsic recombination and intrinsic conduction were the dominant mechanisms, and the peak height at any given frequency depended only upon specimen orientation. If impurities were introduced so that the extrinsic lifetime became less than the intrinsic lifetime at the peak temperature, then the peak height was reduced. From the shape of the electronic peak and from its shift with frequency, the temperature variation of both intrinsic and extrinsic lifetime could be deduced. The activation energy of recombination of carriers in silicon appeared to be 1.45 eV and in germanium about 1.15 eV, although it was difficult to reconcile these values with existing theories. The height of the peak gave the deformation potential constant; in silicon it was 2.3 eV and in germanium 6.5 eV per unit dilational strain, which values were of the same order as those derived from hydrostatic measurements. In silicon crystals containing oxygen, having a [111] vibration axis, an internal friction peak appeared at 1030° C (100 kc/s). The peak was not present if the silicon was oxygen-free or had a [100] axis, and could be attributed to the movement of dissolved oxygen. The activation energy was 2.55 eV. The peak height varied, but in most crystals grown from silica crucibles the maximum logarithmic decrement was of the order 3 × 10^{-4}. In germanium a small peak appeared in some specimens at 770° C (100 kc/s). No reduction of its height was observed on annealing, and its shape was consistent with that of impurity relaxation. See also following abstract.

1304 INTERNAL FRICTION IN GERMANIUM AND SILICON. II. OXYGEN MOVEMENT AND DISLOCATION DAMPING. P.D.Southgate.

Proc. Phys. Soc. (GB), Vol. 76, Pt 3, 398-408 (Sept. 1, 1960).

Measurements of the magnitude of electronic and oxygen impurity relaxation peaks in single-crystal silicon yielded values for the extrinsic carrier lifetime and the relative oxygen concentration, respectively. This method was used to study the production of recombination centres associated with oxygen impurity, and the internal precipitation of oxygen. Recombination centres were induced when oxygen-containing silicon was cooled rapidly from above 1000°C to 650°C, reducing the lifetime to less than 0.35 μsec, which then recovered at a rate which increased with successive heat treatments. Precipitation onto internal particles at 1025°C occurred in the order of 3 hours for 2.7 Ω cm aluminium-doped silicon, and considerably longer for a purer sample, indicating that aluminium acted as an efficient precipitation nucleus. A 2% plastic deformation of the aluminium-doped specimen did not greatly reduce the precipitation time. Analysis of the precipitation-curve form indicated that stresses around the precipitate particles may have been important in determining the precipitation rate. Dislocation relaxation produced a rise in internal friction at elevated temperatures, an activation energy of 1.1 eV in germanium and 1.5 eV in silicon being associated with the rise. In silicon and germanium specimens which were plastically deformed by about 2%, the process became dominant above 0.6 of the melting temperature. Undistorted ("as-grown") specimens showed a rise at higher temperatures, which varied in magnitude between specimens, and which could be due to the same process as that in deformed specimens. Oxygen in silicon appeared to inhibit the loss process. Experimental results were discussed in the light of three possible theories, and it was concluded that there was insufficient evidence to indicate which one was applicable. See also preceding abstract.

1305 THE BEHAVIOUR OF INTERNAL FRICTION ASSOCIATED WITH THE PROCESS OF MARTENSITE-TYPE TRANSFORMATION. Wang Yeh-ning and Chu Chiang-chung.

Scientia Sinica (China), Vol. 9, No. 2, 197-212 (Feb., 1960).

Iron—manganese alloys containing 12.8 and 17.5 wt.% manganese were investigated in a torsion pendulum system oscillating at 1.4 c/s. It was found that the internal friction peaks observed on heating and cooling were associated with the $\gamma \rightarrow \alpha$ and $\alpha \rightarrow \gamma$ transformations. The height of the peaks was proportional to the amount of transformation per cycle and when the oscillation frequency, the heating (or cooling) rate and the stress were kept constant, the peak should have corresponded to the curve of the initial rate of martensite transformation. A.E.Kay

1306 X-RAY STRESS DETERMINATION IN AUSTENITIC STEEL. J.H.S.Neilson.

Brit. J. appl. Phys., Vol. 11, No. 11, 523 (1960).

The use of unfiltered chromium K-radiation, with silver as calibrating substance, is recommended. H.Mykura

1307 ACTIVATION ENERGY FOR DEFORMATION OF METALS AT LOW TEMPERATURES. H.Conrad and H.Wiedersich.

Acta metallurgica (Internat.), Vol. 8, No. 2, 128-30 (Feb., 1960).

Expressions for the activation energy are deduced under the assumption that: (1) the strain rate $\dot{\epsilon}$ can be expressed by $\dot{\epsilon} = A\exp(-G/RT)$ where A is the product of the rate at which attemps to overcome the barrier are made and the strain produced by a successful fluctuation; (2) the "activation energy" H may be a direct function of the temperature $H = H(T, \bar{\sigma})$ where $\bar{\sigma}$ = effective stress. Methods to obtain H and $\bar{\sigma}$ are discussed. From experimental data it was impossible to decide whether H is a function of $\bar{\sigma}$ and/or T. Results of other authors are discussed.

H.E.Schmid

1308 BLUE - BRITTLE ARMCO INGOT IRON. A.W.Sleeswyk.

Acta metallurgica (Internat.), Vol. 8, No. 2, 130-2 (Feb., 1960).

A series of experiments was performed to investigate the character of the irregular stress/strain curves. Very accurate isothermic measurements (±0.05°C) were carried out, the results being shown in three diagrams. Apparently a critical strain rate exists where the local plastic deformation takes place by sudden spurts. The character of the curves varies around the critical value that is assumed to depend on the mean velocity of diffusion of interstitial atoms towards a dislocation. The activation energy was determined, good agreement with other authors being reached.

H.E.Schmid

1309 SHEAR IN ZINC BICRYSTALS. J.M.Galligan, S.Feuerstein and W.Luhman.

Acta metallurgica (Internat.), Vol. 8, No. 2, 135-6 (Feb., 1960).

Bicrystals of zinc of 99.99% purity and single crystals with an orientation similar to one of the components of the bicrystal were deformed in simple shear. The plane of the grain boundary was parallel to the plane containing the shear stress. The single crystals fractured at very much lower stresses than the bicrystals. It is suggested that the grain boundary in the bicrystal is able to absorb any crack nucleus which is initiated during the deformation. Deformation occurred by movement of one grain relative to the other. A.E.Ka

1310 THE ELASTIC—PLASTIC CYLINDER SUBJECTED TO RADIALLY DISTRIBUTED HEAT SOURCE, LATERAL PRESSURE AND AXIAL FORCE WITH APPLICATION TO NUCLEA REACTOR FUEL ELEMENTS.

T.B.Kammash, S.A.Murch and P.M.Naghdi.

J. Mech. Phys. Solids (GB), Vol. 8, No. 1, 1-25 (Jan., 1960).

The elastic—plastic deformation of a solid cylinder in the presence of a distributed heat source and subjected to a lateral pressure p and an axial force F is considered in detail using Tresca's yield function, its associated flow law, and a linear work-hardening law. Particular attention is given to the class of problem in which the radial stress, and not the axial stress, is the intermediate principal stress. The general results are applied to the cylindrical nuclear reactor fuel element in the state of plane strain with a radially distributed Gaussian heat source, acting in its fissionable interior. The solution is expressed in closed form in terms of the exponential integral and the incomplete gamma functio and is found to exhibit three stages of plastic deformation. In stage I the plastic domain consists of two concentric and adjacent zones with different stress fields and different rates of propagation which expand outward from the centre of the cylinder; in stage II the elast domain vanishes, while the inner plastic zone continues to propagat and in stage III a third plastic zone is formed at the outer radius which propagates inward. Throughout the deformation the states ar found to exhibit regular progression. A numerical example is included.

1311 ON THE TORSION OF A THIN-WALL CYLINDER FOLLOWING A PLASTIC EXTENSION.

H.Payne and S.J.Czyzak.

J. Mech. Phys. Solids (GB), Vol. 8, No. 1, 39-44 (Jan., 1960).

The problem of a thin-wall polycrystalline cylinder subjected to a torsional strain following a plastic tensile strain according to an extension of Taylor's theoretical model has been investigated. Some agreement with experimental results has been obtained.

1312 EFFECT OF IRREGULAR HEATING ON THE STABILI OF A COMPRESSED BAR [OF RECTANGULAR CROSS SECTION]. L.A.Shapovalov.

Priklad. Mat. i Mekh. (USSR), Vol. 22, No. 1, 119-23 (1958). In Russian.

The bar suffers small elasto-plastic deformations. The tempe ture field is supposed constant along the bar and to change linearly in the direction of deformation. Under the assumed boundary conditions, irregular heating causes no additional curvature of the bar axis.

1313 INFLUENCE OF INTERMEDIATE PRINCIPAL STRESS ON PLASTIC FLOW. F.Nakanishi and Y.Sato.

Bull. JSME (Japan), Vol. 3, No. 9, 54-9 (Feb., 1960).

Let σ_1, σ_2 and $\sigma_3 (\sigma_1 > \sigma_2 > \sigma_3)$ be the principal stresses, and $\sigma_3 = 0$. Taking σ_1 and σ_2 as axes, the criterion of plastic flow is expressed not by a smooth curve, but a curve composed of two straight lines which intersect at $\sigma_1 = 4\sigma_2$ in the range between tension and pure shear. Experiments were carried out. The resul show that there is an abrupt bend as predicted by the theory.

1314 THE INFLUENCE OF TEMPERATURE AND STRAIN RATE ON THE FLOW STRESS OF MAGNESIUM SINGLE CRYSTALS. Z.S.Basinski.

Austral. J. Phys., Vol. 13, No. 2a, 284-98 (July, 1960).

Solid State Physics Conference (see Abstr. 17864 of 1960). Th temperature and strain-rate dependence of the flow stress of magn sium single crystals was measured in the temperature range 1.45-248°K. Some incidental observations were also made on the form the stress—strain curves and the appearance of slip lines. The de formation characteristics show close similarity with those of the face-centred cubic metals.

1315

THE INFLUENCE OF TEMPERATURE AND STRAIN RATE ON THE FLOW STRESS OF ANNEALED AND ECARBURIZED IRON AT SUBATMOSPHERIC TEMPERATURES.

.S.Basinski and J.W.Christian.

ustral. J. Phys., Vol. 13, No. 2a, 299-308 (July, 1960).

Solid State Physics Conference (see Abstr. 17864 of 1960). The fluence of temperature and strain rate on the flow stress of nnealed and decarburized iron in the stages of uniform deformaon was studied at temperatures down to 78°K. The Cottrell—Stokes w was not obeyed in iron, and the results were explainable in rms of the strong Peierls—Nabarro force in this metal. See also llowing abstract.

1316

THE PEIERLS—NABARRO FORCE AND THE DEFORMATION OF IRON AND STEEL.

N.Louat.

ustral. J. Phys., Vol. 13, No. 2a, 309-15 (July, 1960).

Solid State Physics Conference (see Abstr. 17864 of 1960). vidence for the existence of an appreciable Peierls—Nabarro force ı iron and steel is examined. It is concluded that the observed beaviour is unlikely to follow from the presently proposed mechanism f this force and that the observed frictional stress may arise as a onsequence of dislocations being in pile-ups.

1317

THE PLASTIC RESISTANCE OF CRYSTALS.

J.J.Gilman.

ustral. J. Phys., Vol. 13, No. 2a, 327-46 (July, 1960).

Solid State Physics Conference (see Abstr. 17864 of 1960). vidence is presented in this paper to show that crystals present plastic resistance to dislocation motion. This was demonstrated y direct observations of dislocations in LiF crystals by Johnston nd Gilman (Abstr. 4019 of 1959) and in Fe—Si crystals by Stein nd Low (Abstr. 6042 of 1960). The plastic resistance was almost ndependent of dislocation velocity except at very high velocities. was, however, strongly influenced by temperature, impurities, nd radiation damage. In LiF crystals, the plastic resistance was nuch higher for glide on {100} planes than on {110} planes. It was ound that the yield stresses and indentation hardnesses of many rystals could be correlated with their elastic moduli, provided ne crystal structure type is held constant. For example, for face-entred cubic metals the yield stress was equal to 1.6×10^{-3} G shear modulus) at −200°C. This was taken to mean that one imporant factor that determines the plastic resistance is the elastic nodulus of a crystal. Crystal structure type also had a big effect, o the detailed structure of the core of a dislocation also influenced ne plastic resistance. The temperature dependence of the plastic esistance is discussed. A sharp drop in the plastic resistances of ovalent crystals was observed at a temperature that is roughly qual to two-thirds of the melting temperature. It is suggested that nis was because the cores of dislocation in covalent crystals "melt" t this temperature.

1318

THE INSTABILITY OF PLASTIC FLOW OF METALS AT VERY LOW TEMPERATURES. II.

Z.S.Basinski.

ustral. J. Phys., Vol. 13, No. 2a, 354-8 (July, 1960).

Solid State Physics Conference (see Abstr. 17864 of 1960). For t I,see Proc. Roy. Soc. A, Vol. 240, 229 (1957). Evidence is preented to show that the load drops observed in most metals at very w temperatures arise from thermal instability rather than echanical instability of the lattice. Measurements of the tempeature rise are described.

1319

A LOW TEMPERATURE YIELD INSTABILITY IN IRON.

J.B.Lean.

ustral. J. Phys., Vol. 13, No. 2a, 359-75 (July, 1960).

Solid State Physics Conference (see Abstr. 17864 of 1960). olycrystalline specimens of a 0.07% C steel were tested in ension at liquid-air temperatures. Under particular conditions of mperature and strain rate, following the upper yield point, the reorded stress descended below the lower yield stress then returned the lower yield stress quasi-elastically thus forming a serration n the stress-strain curve. The magnitude of the serration deended on the difference between the upper and lower yield stresses, n the rigidity of the testing machine employed, and on the applied rain rate. In the discussion the mechanical stability of the tensile st during the yield point load drop was examined. The effect of diabatic temperature increase in specimens deformed at low temeratures in boiling liquids was also discussed.

1320

INFLUENCE OF WEAKENING OF A BAR ON THE CRITICAL FORCE IN THE ELASTIC-PLASTIC RANGE.

M.Wnuk and M.Życzkowski.

Bull. Acad. Polon. Sci. Ser. Sci. tech. (Poland), Vol. 7, No. 7-8, 447-57 (1959).

1321

ON THE ASSOCIATED FLOW RULE OF PLASTICITY BASED ON CRYSTAL SLIPS.

T.H.Lin.

J. Franklin Inst. (USA), Vol. 270, No. 4, 291-300 (Oct., 1960).

The associated flow rule has been commonly assumed in the limit analysis of metal structures. In this paper, aggregates of differently orientated metal crystals with finite elastic constants are considered. The coincidence of the plastic potential with yield surface of these polycrystalline aggregates is theoretically derived from the slip characteristics of single crystals. The deviation of the plastic potential from the yield surface of the aggregate increases with the elastic anisotropy of the individual crystals.

1322

A NEW TECHNIQUE FOR ENGRAVING AND MEASURING GRIDS IN EXPERIMENTAL PLASTICITY.

R.C.Brewer and J.M.Alexander.

J. Mech. Phys. Solids (GB), Vol. 8, No. 1, 76-8 (Jan., 1960).

During experimental research into the plastic flow of metals, particularly in metal working processes, it was necessary to engrave and measure grids on metal specimens. By this technique grids are engraved on interior sections of specimens, which are then subjected to some metal working process, the operation being interrupted when the steady state is obtained so that measurements can be made of the deformed grid. In this way it is possible to determine a slip-line field (or the orthogonal network of lines which lie in the direction of principal shear strains), and obtain information about the detailed pattern of stress and strain which exists in the material. Typical examples of specimens partly deformed in rolling and machining are shown diagrammatically, the specimen being formed in two or more laminae so that the grid can be brought to the interior of the specimen where edge effects will not give spurious results, and then secured together either by pressure welding or some form of adhesive. Photographs of typical deformed grids in these processes are shown.

1323

MEASUREMENT OF THE SIZE AND DEGREE OF MISORIENTATION OF SUBGRAINS FORMED DURING CREEP ON THE SURFACE AND IN THE INTERIOR OF A TEST PIECE.

V.M.Rozenberg.

Fiz. Metallov i Metallovedenie (USSR), Vol. 9, No. 4, 621-5 (April, 1960). In Russian.

A specimen of 99.95% Al was extended under a constant load (the initial stress = 0.4 kg/mm²) at 300°C, after which the size of the subgrains, formed on the surface of the test piece, and their orientation were determined by microsopic examination under polarized light. A thin surface layer was then removed by electrolytic etching, the freshly exposed surface was examined, and by repeating this process several times the changes that had taken place in the interior of the testpiece were studied. Since no difference was observed in the size or degree of misorientation of subgrains formed on the surface and in the interior of the metal, it was concluded that deformation within the grains and the movement of the grains relative each other proceed in the same manner both on the surface and in the interior of a creep test piece. M.H.Sloboda

1324

CHANGES OF ULTRASONIC ATTENUATION DURING CREEP OF ALUMINUM.

A.Hikata and M.Tutumi.

J. Phys. Soc. Japan, Vol. 14, No. 5, 687-8 (May, 1959).

Preliminary measurements are reported on attenuation of 5 Mc/s ultrasonic waves in a 99.97% pure aluminium specimen undergoing plastic deformation with constant load. The results show that there is a relationship between the strain rate and the attenuation. L.Mackinnon

1325

STEADY-STATE CREEP OF TIN NEAR THE MELTING POINT.

W.A.Zama, D.D.Lang and F.R.Brotzen.

J. Mech. Phys. Solids (GB), Vol. 8, No. 1, 45-51 (Jan. 1960).

The steady-state creep rates of commercial tin were investigated at temperatures between 180 and 230 °C. Torsional creep equipment was developed for this purpose. At temperatures below 215 °C results indicate that the steady-state creep process is one governed by a single activation energy of 22 500 cal/mole. At higher temperatures, however, the simple Arrhenius-type equation cannot properly express the creep behaviour.

1326 A SIMPLE METHOD OF INVESTIGATING THE CREEP OF METALS UNDER SIMPLE SHEAR.

E.N.da C.Andrade.
Nature (GB), Vol. 187, 494 (Aug. 6, 1960).

1327 ON MICROCREEP IN ZINC WHISKERS.

P.B.Price.
Phil. Mag. (Eighth Ser.)(GB), Vol. 5, 417-19 (April, 1960).

Zinc whiskers were examined by transmission electron microscopy; many were free of dislocations, but some contained dislocations which were mainly on the basal plane. All the crystals could be stressed to high strains ($\sim 10^{-2}$) before yielding. Dislocation-free crystals showed no plastic flow below the yield point, but microcreep was observed in crystals containing dislocations. H.Mykura

1328 POLYSLIP IN SINGLE CRYSTALS.

U.F.Kocks.
Acta metallurgica (Internat.), Vol. 8, No. 6, 345-52 (June, 1960).

Simultaneous slip on six or eight glide systems in f.c.c. single crystals was studied by work-hardening, surface, and X-ray observations, and theoretically. Experiments were done on aluminium at room temperature, on four of the five crystallographic types of polyslip. They show that there are two extremely different kinds of behaviour, typified by $\langle 100 \rangle$ and $\langle 111 \rangle$ tension. These differences cannot be explained by any of the known mechanisms. Two additional mechanisms are proposed, one for the suppression of "critical" glide systems by the formation of large sessile jogs; the other concerning the action of pile-ups as "hedges" for intersecting glide systems.

1329 SOME OBSERVATIONS OF SLIP LINES ON DEFORMED COPPER WHISKERS.

P.Charsley.
Acta metallurgica (Internat.), Vol. 8, No. 6, 353-5 (June, 1960).

Observations on slip markings which are produced during the tensile deformation of copper whiskers indicate that visible cross-slip does not necessarily occur during the propagation of a Lüders band. A mechanism is proposed whereby such a band propagates as a result of the stress concentration between the slipped and unslipped regions of the whisker.

1330 INFLUENCE OF ANNEALING ON THE STRUCTURE OF THE CRYSTAL LATTICE IN A SLIP BAND OF ROCK SALT.

V.I.Startsev and P.N.Aronova.
Kristallografiya (USSR), Vol. 4, No. 3, 438-40 (May-June, 1959).
In Russian. English translation in: Soviet Physics—Crystallography (USA), Vol. 4, No. 3, 412-14 (March, 1960).

The authors have previously shown (Abstr. 13857 of 1959) that the Debye temperature drops sharply in the slip band region compared with the bulk crystal. The present work is a study of the annealing characteristics of this region and it is shown that in rock salt the crystal lattice in the slip band is in an unstable state; after annealing near the melting point the Debye temperature rises to the value appropriate to the undeformed crystal lattice. The kinetics of this restoration of Debye temperature is studied and found to have a surprising temperature dependence. R.Bullough

1331 ON STRESS-AIDED CROSS-SLIP OF DISLOCATIONS.

C.J.Ball.
Phil. Mag. (GB) (Eighth Ser.), Vol. 4, 1377-8 (Dec., 1959).

The constriction stresses at the head of a pile-up of dislocations are discussed in some detail and it is concluded that at low temperatures these stresses will be insufficient to force the partials completely together. It is suggested that the number of dislocations in a pile-up required to produce cross-slip must be greater than 25 [see Dislocations and Mechanical Properties of Crystals. A.Seeger. New York: J.Wiley and Sons (1957)]. R.Bullough

1332 THE ORIENTATION DEPENDENCE OF WORK-HARDENING IN CRYSTALS OF FACE-CENTRED CUBIC METALS.

L.M.Clarebrough and M.E.Hargreaves.
Austral. J. Phys., Vol. 13, No. 2a, 316-26 (July, 1960).

Solid State Physics Conference (see Abstr. 17864 of 1960). It is shown that the principal features of the observed orientation dependence of work-hardening can be accounted for in terms of the likelihood of formation of Lomer—Cottrell sessile dislocations in two directions in the primary slip plane. This is deduced from the known variation of resolved shear stress with orientation, for the possible secondary slip systems, and metallographic observations of slip and deformation bands.

1333 THE TEMPERATURE AND RATE DEPENDENCE OF WORK HARDENING IN CUBIC FACE-CENTRED SINGLE CRYSTALS.

R.Berner.
Z. Naturforsch. (Germany), Vol. 15a, No. 8, 689-706 (Aug., 1960).
In German.

Work hardening experiments using Cu, Au and Al single crystals are described. The stacking-fault energy in Cu was determined from the rate dependence of the stress τ_{111}. The energies for Au and Al were found by comparing the temperature dependence of τ_{111} for those metals with the corresponding results for Cu. Consistent supplementary measurements of cross slips are reported in the case of Au. J.W.Leech

1334 WORK-HARDENING AND RECOVERY OF HIGH PURITY TUNGSTEN AND MOLYBDENUM [DEFORMED] UNDER THE CONDITIONS OF NON-UNIFORM TRIAXIAL COMPRESSION.

I.N.Frantsevich, I.E.Shiyanovskaya and V.A.Lavrenko.
Fiz. Metallov i Metallovedenie (USSR), Vol. 9, No. 4, 593-8 (April, 1960). In Russian.

From the temperature dependence of microhardness of plastically deformed specimens, the recrystallization temperature of Mo (~ 1000° C) and W (~ 1350° C) were determined. The results of harmonic analysis of the energy distribution in X-ray diffraction lines indicated that in the case of Mo and W, deformed by non-unifor triaxial compressive stresses, the broadening of X-ray lines is caus by micro-defects only. M.H.Sloboda

1335 INFLUENCE OF COLD WORK ON THE RIGIDITY OF COPPER.

M.J.Druyvesteyn, O.F.Z.Schannen and E.C.J.Swaving.
Physica (Netherlands), Vol. 25, No. 12, 1271-4 (Dec., 1959).

A decrease of the rigidity of Cu and Ag of about 17% after a plastic deformation of about 0.1% at −190° C was observed. The recovery of this effect between −190° and +80° C was studied.

1336 THE HARDENING OF COPPER BY NEUTRON IRRADIATION.

M.A.Adams and P.R.B.Higgins.
Phil. Mag. (GB) (Eighth Ser.), Vol. 4, 777-80 (June, 1959).

Pure copper wires with a range of grain sizes were irradiated by fast neutrons, and their tensile strength measured at 20° C and −78° C. From the observed changes in yield point it is concluded that neutron irradiation makes more difficult both slip nucleation (source hardening) and slip propagation (lattice friction); and that the temperature dependence is due to lattice friction. H.Mykur

1337 THE TIME-DEPENDENCE OF RESISTANCE TO DEFORMATION IN ACTIVE TENSION.

B.M.Rovinskii and L.M.Rȳbakova.
Fiz. Metallov i Metallovedenie (USSR), Vol. 9, No. 4, 598-605 (April, 1960). In Russian.

Time-to-rupture tests were carried out under the conditions o constant strain on both standard and notched cylindrical specimens of annealed Al, Cu, Ni, Armco Fe, and Duralumin. It was shown that time-to-rupture, τ, is given by $\tau = \tau_0{}^* \exp - \alpha \bar{S}$, where $\bar{S}$ is the mean effective true stress, acting on the specimen during time τ. Introduction of stress-risers affected only the magnitude of α in the above relationship which, however, is not valid for metals undergoing structural transformations (e.g. ageing) during testing. Irrespective of τ and the rate of strain employed, macroscopic fracture of any given specimen occurred after it had been deformed to a certain degree which depended on the nature of the metal and the stress concentration gradient across the cross-section of the specimen. M.H.Slobod

1338 THE EFFECT OF PRELIMINARY THERMAL CYCLING AND PLASTIC DEFORMATION OF STRENG AND TIME-TO-RUPTURE CHARACTERISTICS ON METALS.

B.M.Rovinskii and L.M.Rȳbakova.
Fiz. Metallov i Metallovedenie (USSR), Vol. 9, No. 4, 606-12 (April, 1960). In Russian.

It was shown that the time-dependence of strength of Cu specimens, subjected to preliminary thermal cycling (heating to 650° C, 10 min at the temperature, quenching) or plastic deformation, is described by $\tau = \tau_0{}^* \exp - \alpha \bar{S}$, where τ is time-to-rupture and $\bar{S}$ denotes the mean effective true stress acting on the specimen durin time τ. It was inferred from the results obtained that micro-pore formed during thermal cycling, and defects due to plastic deformation affect the time-to-rupture characteristics of metals in the sam was as prolonged loading. M.H.Slobod

1339 PREDICTION OF FATIGUE LIFE.
A.M.Freudenthal.

. appl. Phys. (USA), Vol. 31, No. 12, 2196-8 (Dec., 1960).

On the basis of the relation between the "reliability-function" robability of surviving beyond age N in cycles or t in time) and the risk" of failure (as a function of age), the physical interpretation of ne latter can be used to extrapolate the former beyond the range of ossible observation. It is shown that the asymptotic distribution f smallest values is compatible with the physical concept of (dynamic r static) fatigue, while the logarithmic-normal distribution is not.

1340 RANDOM SLIP MODEL OF FATIGUE AND COFFIN'S LAW.
A.N.May.

ature (GB), Vol. 188, 573-4 (Nov. 12, 1960).

Coffin's relation between the number of cycles to fracture n and ne plastic strain ϵ in each cycle, $n^{1/2}\epsilon$ = const., is interpreted in erms of May's random slip model of fatigue (Abstr. 6320 of 1960). is pointed out that the equation is still valid for $n = \frac{1}{4}$, which uggests that the formation of small notches by slip may be relevant simple ductile fracture as well as in fatigue. A.E.Kay

1341 APPLICATION OF STROH'S THEORY TO INTERCRYSTALLINE CREEP CRACKING.
C.W.Weaver.

cta metallurgica (Internat.), Vol. 8, No. 5, 343-4 (May, 1960).

Stroh's formula (Abstr. 6941 of 1954) as used by McLean J. Inst. Metals. Vol. 85, 468 (1956-57)] is used to explain the uppression of triple-point cracking in Nimonic 80 A type alloys. J.E.Caffyn

1342 FURTHER OBSERVATIONS OF STROH-CRACKS IN MAGNESIUM OXIDE SINGLE CRYSTALS.
.J.Stokes, T.L.Johnston and C.H.Li.

hil. Mag. (Eighth Ser.) (GB), Vol. 4, 137-8 (Jan., 1959).

In a previous paper (Abstr. 6430 of 1958) the authors reported ne existence, in magnesium oxide single crystals, of Stroh cracks uring severe compression experiments. The present work describes the appearance of such Stroh cracks in the same material fter simple bending; the cracks invariably originate in areas where lip planes intersect. R.Bullough

1343 ON NON-PROPAGATING CRACKS IN FATIGUE OF METALS.
M.Kawamoto and K.Kimura.

ull. JSME (Japan), Vol. 3, No. 9, 41-7 (Feb., 1960).

A new hypothesis for formation is proposed. The hypothesis is ased on coaxing, strain hardening and other effects, which the elated material receives at the tip of a fatigue crack. The material t the tip of a fatigue crack is considered to be stronger at inner parts nan near the surface. The fatigue strengths for the formation of racks and for destruction are considered. A critical value of the atigue strength reduction factor, i.e. the minimum value for fornation of a non-propagating crack, is also considered. The reation between the critical fatigue strength reduction factor and the atigue strength of the two kinds above mentioned is obtained from ne hypothesis proposed. The reduced relations were compared with ne results of experiments made on rotating bending and repeated orsion, and good agreement found.

1344 THE QUESTION OF FORMATION CONDITIONS AND DEVELOPMENT OF CRACKS IN CRYSTALS.
/.N.Rozhanskii.

Fiz. tverdogo Tela (USSR), Vol. 2, No. 6, 1082-8 (June, 1960). In Russian.

The strength of zinc whisker crystals 0.5-100 μ in diameter vas determined as a function of diameter 2 hours and 30 hours after ormation. The effect of surface amalgamation with mercury was lso determined. The strength decreased with increase in diameter nd with time after formation; the amalgamation treatment also owered the strength except at the smallest diameters. The results howed that the accumulation of dislocations leads to the formation f Griffiths cracks, and confirmatory observations on zinc foil are eported. [English translation in: Soviet Physics—Solid State (USA)]. R.F.S.Hearmon

1345 VELOCITY BEHAVIOR OF A GROWING CRACK.
E.N.Dulaney and W.F.Brace.

. ppl. Phys. (USA), Vol. 31, No. 12, 2233-6 (Dec., 1960).

An expression for the velocity behaviour of a growing crack in . plate of brittle material is obtained by a mathematical refinement of the Mott energy balance around a moving crack. Crack velocity c is given by

$$c = V_T(1 - c_0/c),$$

where V_T is terminal crack velocity, c is instantaneous half-crack length, and c_0 is initial half-crack length. This predicts that velocity makes a hyperbolic asymtotic approach to terminal velocity. Growing cracks in large sheets of polymethyl methacrylate approach terminal velocity over three-quarters of their length as predicted by this theory but as though from an initial crack larger than the actual initiating crack. This is interpreted as due to energy losses at the very beginning of crack growth not included in the Mott energy balance.

1346 ON THE PROPAGATION OF A CRACK IN AN ELASTIC-BRITTLE MATERIAL.
J.W.Craggs.

J. Mech. Phys. Solids (GB), Vol. 8, No. 1, 66-75 (Jan., 1960).

The Griffith theory of brittle cracking is extended to a dynamic problem, in which a semi-infinite crack in an infinite medium is extended by finite forces. The conclusion is drawn that the force required to maintain a steady rate of extension of the crack decreases as the rate increases. It is also observed that various criteria which may be assumed for crack division lead to limiting velocities of propagation of a single crack.

1347 DETECTION OF STRENGTH-IMPAIRING SURFACE FLAWS IN GLASS.
F.M.Ernsberger.

Proc. Roy. Soc. A (GB), Vol. 257, 213-23 (Sept. 6, 1960).

Experiments have shown that the cracks produced by sodium vapour treatment on the surface of glass (Andrade and Tsien, 1937) are fractures due to a superficial tensile stress developed on cooling in a surface layer of higher thermal expansion. Tensile surface stresses and corresponding systems of cracks can also be developed, in soda-lime glass, by treatment with a molten lithium salt. The points of origin of the crack systems can be clearly recognized; they must be the sites of Griffith cracks. The structure (linear or star-like) of each Griffith crack can be recognized from the orientation of the network cracks at the point in question. The experimental evidence for the present interpretation of the Andrade—Tsien cracks is as follows: (1) A large amount of sodium is absorbed in the surface layer of the glass. (2) The characteristic crack patterns are not visible at the end of the heating period in sodium vapour, but appear progressively as the sodium-treated glass cools. (3) The cracks disappear when the glass is reheated, and a new pattern appears on subsequent cooling.

1348 THE STRENGTH OF GLASS.
D.G.Holloway.

Contemporary Physics (GB), Vol. 1, No. 3, 230-5 (Feb., 1960).

Large differences exist between the theoretical and experimental values of the mechanical strength of solids. Features of this phenomenon for glass are outlined together with a review of the current, incomplete explanation.

1349 IMPAIRMENT OF STRENGTH OF QUARTZ GLASS THROUGH WETTING BY LIQUIDS.
K.H.Hiller.

Nature (GB), Vol. 188, 132-3 (Oct. 8, 1960).

Measurements were made of the breaking strength of quartz glass rods in three-point bending when immersed in distilled water, oleylamine, and n-hexadecane. The results were consistent with the hypothesis that immersion in a liquid lowers the interfacial free energy and thus the critical tensile stress necessary to propagate a crack. The variations in strength cannot be explained exclusively on the basis of a process of chemical solution. D.M.Schlapp

1350 MEASUREMENT OF HARDNESS AT VERY HIGH TEMPERATURES.
L.M.Fitzgerald.

Brit. J. appl. Phys., Vol. 11, No. 12, 551-4 (Dec., 1960).

A new method of determining hardness at high temperatures has been developed and is being used, particularly, to study materials having melting-points in the region of 3000° C. The principle of the hardness measurement is the determination of the height of rebound of a spherical indenter. Tungsten-carbide balls of diameter $\frac{1}{8}$ in. are dropped on to the specimen from a height of about 22 in. The method of measurement makes use of a photomultiplier tube and an electronic timing device. A graphite-tube resistance-heated furnace is used to obtain the temperatures required. The furnace chamber and measuring apparatus is maintained at a vacuum of 0.1 μ (10^{-4} mm of mercury) and is also surrounded by a water-cooling jacket. The plastic deformation of hard carbides as the temperature is increased has been measured with this apparatus. Some typical results are given.

1351 THE INDENTATION HARDNESS OF DIAMONDS.

A.M.Shams el Din and H.J.Rodewald.

Schweiz. Arch. angew. Wiss. Tech. (Switzerland), Vol. 26, No. 6, 250-3 (June, 1960). In German.

The hardness of diamonds as measured by the Vickers' indentation machine or by a three-sided pyramidal indenting tool ranges from 10 000 to over 50 000 kp/sq mm when computed by the conventional formula. When G is the applied load in grammes and d is the length of the diagonal in the case of the Vickers' machine, or the height of the triangular indentation when the three-sided pyramid is employed, the conventional formula gives the hardness as = $(\text{constant} \times G)/d^2$, the constant depending on the shape of the tool. The range of the hardness values is reduced to 9000-13 000 kp/sq mm when expressed in the form $H = \text{const.}\ (G - k)/d^2$, where k is deduced from tests at two loads or by plotting the data obtained at various loads. A.C.Whiffin

1352 SURFACE RE-ORIENTATION, FRICTION AND WEAR, IN THE UNIDIRECTIONAL ABRASION OF GRAPHITE.

P.V.K.Porgess and H.Wilman.

Proc. Phys. Soc. (GB), Vol. 76, Pt 4, 513-25 (Oct. 1, 1960).

Surface structure, friction and wear were investigated and correlated in the case of abrasion of graphite by emery papers of particle diameter D = 5 to 150 microns. For graphite and also for metals, the coefficient of friction μ of specimens approximately 1 cm long or more was low on the fine grades of emery, but rose rapidly with increasing D and then was practically constant at $D > 50$ microns. The ploughing component μ_p was concluded to be larger than the adhesion component μ_a when D was of the order of 30 microns or more. Earlier views that μ_p increased linearly with D and was always small were evidently incorrect. Electron diffraction showed that the abrasion causes a re-orientation of the graphite at and near the surface by plastic flow (slip) on (0001). A [001] "fibre orientation" was developed (the usual compression texture) with its mean axis along the resultant of the normal load and the tangential frictional force, at $\tan^{-1}\mu$ (whatever the value of μ) to the specimen normal, towards the direction from which the abrasive particles came. The wear per unit distance M also rose rapidly with D and then showed a much slower rate of increase at $D > 80$ microns. The plot of M against μ was a strongly curved locus at 200 g load, and was still curved even at 25 g load, for graphite; while for metals it was linear at least up to 2 kg load (Goddard, Harker and Wilman, 1959). The difference in nature of the abrasion was also seen microscopically; cracking and some breakaway of graphite fragments occurred near the individual grooves, and was associated with a volume-wear rate about four times that of metals, at $D > 50$ microns. A method of comparing the hardness of the work-hardened surface regions of abraded materials in terms of abrasion-groove widths was described. For the graphite specimen used this was of the order of one-fifth that of silver; the effective Vickers hardness was thus of the order of 20, and this agreed with estimates made using a diamond indenter.

1353 AN EXPERIMENTAL STUDY OF FRICTION AND WEAR DURING ABRASION OF METALS.

B.W.E.Avient, J.Goddard and H.Wilman.

Proc. Roy. Soc. A (GB), Vol. 258, 159-80 (Oct. 18, 1960).

The friction coefficient μ and the mass loss M' per centimetre, of Al, Ag, Cu, Pt, Fe, Mo, U and W specimens ~ 1 to 2.5 cm long were investigated as a function of the mean particle diameter D of abrading emery-paper surfaces (dry) on which they slid at a few cm/sec and ~ 1 kg load: On any grade of abrasive, μ and M' varied with distance of sliding, M' decreasing and μ increasing for initially wet-abraded metals, due to progressive pick-up of emery by the metal surface. After 200 to 500 cm, depending on the metal and the grade of abrasive, they became constant (M' then is wear of metal only, M) and independent of the initial surface preparation. The value of μ did not increase linearly with D as suggested by previous authors (who used small specimens, smaller range of D, and neglected the effect of pick-up of abrasive). For any given metal, μ (initially and at equilibrium) was practically constant, μ_{max}, at D from 70 to > 150 microns, and decreases with increasing hardness of the metal, at equilibrium being 0.88 for Al, to 0.53 for W. At $D < 70$, μ decreasd — in general to ~ 0.3 to 0.4 for specimens 1 to 2.5 cm dia. — due to partial clogging of the abrasive by worn-off metal. The high and constant μ_{max} on emery- and glass-papers was due to the angular shape of the abrasive particles, since μ was only 0.15 for Ag and Cu on an array of glass spheres of D ~ 125 microns For the metals initially abraded on wet emery, then slid on dry emer papers, M at equilibrium also increased with D and was practicall constant at $D > 70$ microns; and $M \cong kW(\mu-\mu_0)$, where W is the loa and μ_0 is a constant, in general $> \mu_{mo.mo}$ of metal-oxide on metal-oxide because of pick-up of abrasive particles by the metal. $1/(M/\rho)$, the reciprocal of the volume wear per cm, was approximately proportional to the Vickers hardness H_D of the abraded metal surface. Most of the indenting particles caused wear in the form of strips of metal analogous to those caused by machine tools, but there was also much plastic flow (and lateral pile-up) as electron diffraction indicated. A theory defining friction and wear of metals in abrasion in terms of the shape and orientation of the abrasive particles, is given elsewhere, together with quantitative analysis of the present data. For emery-papers, only about 10% of the groove volume (on the average) appeared to be removed as wear.

1354 MOTION OF MOLECULES IN VERY THIN FILMS BETWEEN SLIDING SURFACES. B.S.Thornton.

Nature (GB), Vol. 188, 802 (Dec. 3, 1960).

The magnitude of the changes in the tangential force was observed at the commencement of, and during, sliding with "stick—slip" motion of optically flat lapped steel surfaces separated by several molecular layers of stearic acid. The magnitudes of the tangential-force changes tended to be grouped around multiples of a definite value a. It is suggested that sliding had occurred at selecte planes of slip which exist by virtue of the molecular surface orientation forces. R.Schnurmann

1355 MEASUREMENT OF DISPLACEMENT FORCE OF SEVERAL MATERIALS AT PRESSURES UP TO 100 000 ATMOSPHERES. L.F.Vereshchagin and E.V.Zubova.

Dokl. Akad. Nauk SSSR, Vol. 134, No. 4, 787-8 (Oct. 1, 1960).
In Russian.

Specimens of materials used for lubrication in high pressure systems (eg. graphite, AgCl, Mg etc) were compressed between two pistons one of which rotated round its axis. The specimens were in powder form or small discs (0.1 mm thick). The displacement force increases linearly with pressure up to about 100 000 atm, so that it i 3 - 4 times higher than the pressure at 25 000 atm. For graphite however, the force increases more rapidly and at 500 000 atm it is 16 times greater than that at 100 000 atm. J.K.Skwirzynsk

STRUCTURE OF SOLIDS

1356 STUDY ON THE PHASE TRANSITION OF AMMONIUM NITRATE BY DIELECTRIC OBSERVATION AND BY DIFFERENTIAL THERMAL ANALYSIS.

K.Kamiyoshi and T.Yamakami.

Sci. Rep. Res. Insts Tohoku Univ. A (Japan), Vol. 11, No. 5, 418-21 (Oct., 1959).

Phase transitions of ammonium nitrate, NH_4NO_3 were observed by the dielectric measurement (1 kc/s ~ 10 Mc/s) and by the differential thermal analysis. Four phase changes were confirmed between $-100^\circ C$ and $130^\circ C$, of which some had large thermal hyster sis. A reported phase transition at $-60.4^\circ C$ was not observed. A large and sharp peak was observed on some specimens at $41^\circ C$ on heating, which was probably due to the small quantity of water adsorbed on the surface. This peak was never observed on cooling.

CRYSTALLOGRAPHY

1357 FORMATION AND LIQUIDATION OF HETEROGENEOU REGIONS IN SINGLE CRYSTALS OF SOLID (K, Na)Cl SOLUTIONS. A.M.Elistratov and R.A.Zvinchuk.

Fiz. tverdogo Tela (USSR), Vol. 2, No. 10, 2370-83 (Oct., 1960).
In Russian.

Decomposition and multiple homogenization of nearly equimola solid solutions of (K, Na)Cl are studied by Laue X-ray diffraction, by microscopic investigation in linearly polarized light, and by photometric investigation of turbidity. The observed time and temperature effects lead to the conclusion that the decomposition takes place in two stages: (1) the spontaneous formation of local heterogeneous regions and (2) the recrystallization of the equilibri phase. [English translation in: Soviet Physics—Solid State (USA)]. R.F.S.Hearm

1358 A QUANTITATIVE MEASURE OF TEXTURE IN POLY-CRYSTALLINE MATERIALS: TEXTURE FUNCTION.

.S.Biglin.

iz. tverdogo Tela (USSR), Vol. 2, No. 10, 2463-76 (Oct., 1960). Russian.

The specification of texture in terms of the orientation distri- ution of single crystal grains composing a polycrystalline material discussed, and the case of a material in which the individual rains are of cubic symmetry is developed in detail. A method is iggested for the experimental determination of the texture function ferromagnetic materials by measurement of torque in an external agnetic field. [English translation in: Soviet Physics — Solid ate (USA)].

R.F.S.Hearmon

1359 ON THE POLYMORPHISM OF THE THALLIUM HALIDES. I.H.Khan.

roc. Phys. Soc. (GB), Vol. 76, Pt 4, 507-12 (Oct. 1, 1960).

Describes experiments on the polymorphism of thallium halides ormed as thin oriented layers by deposition in vacuo onto a variety f bases, in particular onto cleavage faces of crystals. The effect f varying the temperature of the base was studied in some detail. leasurements were made of the lattice constant of the abnormal ocksalt-type form, using both the reflection and the transmission echniques. In the latter, which gives more accurate results, hallium halides were deposited on to a thin polycrystalline layer of n alkali halide previously formed on an amorphous base.

1360 CHARTS FOR DETERMINATION OF CRYSTAL ORIENTATION BY SURFACE TRACES IN CUBIC RYSTALS. S.Takeuchi, T.Honma and S.Ikeda.

ci. Rep. Res. Insts Tohoku Univ. A (Japan), Vol. 11, No. 2, 81-93 pril, 1959).

A useful method for the determination of the orientations of rystal grains in polycrystalline specimens having cubic lattice ructure was found from the observation of angles between the urface traces such as slip lines, annealing twins or etch-pits which re developed in $\{111\}$ or $\{100\}$ planes. From the computation of elations between the angular coordinates (ξ,η) of the crystal rientation and the intertrace angles $(\alpha,\beta,$ etc) in various directions $\{111\}$ or $\{100\}$ traces, isogonic lines of the intertrace angles ere plotted at the interval of two degrees. The case of $\{111\}$ traces ly in three directions was also discussed, and the relations between e angles of the three traces and the number of possible orien- tions corresponding to the same traces were explained. When the gle between the $\{100\}$ traces was large, considerable errors were avoidable in determining the orientations, but an accurate termination was possible if $\{100\}$ and $\{111\}$ traces were used in mbination. The relations for such a combination were also calcu- ted and plotted in the form of chart. By using these charts, the ystallographic orientations of crystal grains could be determined ry rapidly and accurately.

1361 INTERFEROMETRIC STUDIES OF DEFORMATION BANDS IN METAL CRYSTALS. B.D.Sharma.

sci industr. Res. (India), Vol. 19B, No. 6, 180-3 (June, 1960).

The structural characteristics of twin, kink and deformation ands in Bi and Sn crystals were investigated using multiple beam terferometry. The bands were found to be accompanied by a ttice rotation of the region within the band with respect to the ystal outside. The values of lattice rotation were determined om the geometry of fringes passing over the structures. Deforma- on bands revealed extensive structural changes during annealing in cordance with Mott's concept. The origin and properties of the formation bands are discussed in terms of dislocation networks thin the crystals. The dislocation densities, of the order of ^{10} cm^{-2}, along the band boundaries are evaluated from the lattice tation measurements.

1362 SURFACE MEASUREMENTS ON FRESHLY CLEAVED SILICON p—n JUNCTIONS. G.W.Gobeli and F.G.Allen.

. Phys. Chem. Solids (GB), Vol. 14, 23-6 (July, 1960).

Silicon (111) faces 1.5 mm × 6 mm in area and free of visible nperfections, containing a p—n junction, have been produced by leavage in high vacuum. The cleavage features and the technique re discussed. Contact potential difference (Kelvin method) across ie junction indicates bending of the bands at the surface due to urface states by many tenths of a volt.

1363 THE INFLUENCE OF DEFECT SITES ON THE CHEMICAL STRUCTURE OF PHOSPHORESCENT CALCITE. I.Hanke.

Acta phys. Austriaca, Vol. 13, No. 4, 483-95 (1960). In German.

Fresh cleavage faces were etched with dilute acetic acid, which produced pits in the form of deep pyramids, deep truncated pyra- mids, and shallow truncated pyramids. Most of these pits are unsymmetrical in depth, and have stepped sides if made by the lower concentrations of acid. Some are packed densely, others are scattered or occur in chains parallel to a rhombohedral edge. The shallow pits number 5.6×10^8 cm^{-2}, while the deeper ones vary from 10^3 to 2×10^5 cm^{-2}. Similar effects are found for normal calcite, though size, number and symmetry of the pits are different. For etching times up to 100 sec the volume of calcite removed is proportional to t^3. Several photomicrographs are given.

S.T.Henderson

1364 ETCHING LEAD FOR EXAMINATION IN POLARIZED LIGHT. R.C.Gifkins and J.M.Nicholls.

J. Inst. Metals (GB), Vol. 88, Pt 2, 96 (Oct., 1959).

Gives the composition of an etching solution which gives excellent contrast in polarized light. The technique described is capable of revealing orientation changes of about 2°, by the exam- ination of lineage structures in single crystals. J.Thewlis

1365 CUBIC AND OCTAHEDRAL ETCH PITS IN ALUMINIUM. M.Allbutt.

J. Inst. Metals (GB), Vol. 88, Pt 4, 190 (Dec., 1959).

Observations on the etching of annealed 99.99% aluminium by various solutions containing HCl indicate that water is a factor in the production of cubic etch pits rather than pits of octahedral form.

W.Bardsley

1366 ETCH-FIGURE IN CdS SINGLE CRYSTALS. M.Kikuchi and S.Iizima.

J. Phys. Soc. Japan, Vol. 14, No. 11, 1638 (Nov., 1959).

CdS crystals were grown in vacuum at 1225°C for 100 hr. Large single crystals were obtained, the direction of growth being often parallel to the c-axis. Etch patterns on (1000) planes produced by conc. HCl showed a 6-fold symmetry. J.Franks

1367 ETCHING AND INHIBITION OF THE $\{111\}$ SURFACES OF THE III—V INTERMETALLIC COMPOUNDS: InSb. H.C.Gatos and M.C.Lavine.

J. Phys. Chem. Solids (GB), Vol. 14, 169-74 (July, 1960).

In oxidizing etching media, the $\{111\}$ surfaces of InSb are much less reactive than the $\{\bar{1}\bar{1}\bar{1}\}$ surfaces as determined by direct dis- solution rates and by etching of spheres. Related to this difference in reactivity is the fact that dislocation etch pits appear on the $\{111\}$, but not on the $\{\bar{1}\bar{1}\bar{1}\}$ surfaces. Inhibitors such as stearic acid and primary amines decrease appreciably the dissolution rate of only the $\{\bar{1}\bar{1}\bar{1}\}$ surfaces. Furthermore, etching inhibitors lead to the formation of new dislocation etch pits on the $\{111\}$ and also on the $\{\bar{1}\bar{1}\bar{1}\}$ surfaces. Similar effects were observed in GaAs. These phenomena are dis- cussed in terms of the atomic configuration of the surfaces involved and the relative reactivity of the group III and group V atoms.

1368 GROWTH FROM THE MELT. II. CELLULAR INTER-FACE MORPHOLOGY. G.F.Bolling and W.A.Tiller.

J. appl. Phys. (USA), Vol. 31, No. 11, 2040-5 (Nov., 1960).

For Pt I, see Abstr. 13947 of 1960. The microscopic shape of a solid—liquid interface has been examined theoretically for those growth conditions which give rise to a cellular morphology. The method of obtaining a general solution is set forth, and approximate treatments are used to compare the theoretical approach with experimental data. The variation of cell size with temperature gradients, growth velocity, stirring in the liquid, interfacial free energy, and solute content is examined, and the conditions governing the stability of a cellular interface compared to that of a smooth interface are predicted.

1369 NUCLEATION AND GROWTH OF ICE CRYSTALS UPON CRYSTALLINE SUBSTRATES. N.H.Fletcher.

Austral. J. Phys., Vol.13, No. 2a, 408-18 (July, 1960).

Solid State Physics Conference (see Abstr. 17864 of 1960). The importance of various surface imperfections in the nucleation of ice crystals is considered and it is concluded that dislocations are not preferred nucleation sites, whereas steps and re-entrant corners do encourage nucleation. Expressions are derived for the height of the free-energy barrier in several important cases, and the retention of embryos under unsaturated conditions is discussed. Embryos initially grow by two-dimensional nucleation, but ultimately a dislocation growth mechanism becomes more important. There is not yet enough experimental evidence to decide upon the reality of the entropy effect previously proposed, which inhibits nucleation upon certain crystal faces.

1370 NUCLEATION IN RECRYSTALLIZATION PHENOMENA.

R.A.Oriani.

Acta metallurgica (Internat.), Vol. 8, No. 2, 134-5 (Feb., 1960).

Thermodynamic reasoning is used to determine the conditions under which nucleation is an essential step in the change from one state to another. The ideas are then used to examine the problem of the transformation of a cold-worked crystal to the annealed condition. Usually transformation will proceed by the progressive annihilation of dislocations due to vacancy migration. It is concluded that if nucleation occurs in the recrystallization process it must be a rare event and its contribution to the process must be very slight.

A.E.Kay

1371 CRYSTALLIZATION FROM DILUTE METAL SOLUTIONS.

L.Benjamin and R.F.Strickland-Constable.

Acta Metallurgica (Internat.), Vol. 8, No. 6, 362-72 (June, 1960).

The nucleation and crystal growth from solutions of zinc in mercury was studied; the test amalgam formed one pole of a concentration cell whose e.m.f. was used as a continuous measure of the concentration. The metastable region in which spontaneous nucleation could not occur extended to 2°C below the saturation temperature. Nucleation at temperatures below the metastable region normally produced a crop of fine crystals mainly suspended in the liquid phase, which sometimes subsequently aggregated into a solid cap at the surface or walls. The rate of nucleation varied approximately as $\exp(-\mathrm{const}/\Delta T^2)$. Stirring increased the nucleation rate by only a factor of about 5. The rates observed were immensely greater than those reported by Hollomon and Turnbull for pure metals subdivided into small drops: this would suggest heterogeneous nucleation on foreign particles. But if a first crop of crystals was allowed to form and removed from the system the subsequent rate of nucleation was not significantly reduced by this treatment, and this would suggest that the rate cannot depend on the presence of foreign particles. One possible explanation is that nucleation may all occur only at the glass wall, and the growing crystallites are subsequently floated into the solution. Another depends on the further observation that if a small number of crystals is added to a solution cooled at such a rate as to keep it within the metastable region (where spontaneous nucleation cannot otherwise occur) an immense crop of nuclei is produced equal in number to that obtained with spontaneous nucleation at temperatures below the metastable region: in other words it would appear that nuclei breed nuclei with a high multiplication factor. The high rates of nucleation of a bulk liquid phase may therefore be due to this breeding of nuclei, and not to heterogeneous nucleation. If massive zinc is added to an amalgam which is in equilibrium with a solid phase which has been obtained by cooling a solution from higher temperatures, the massive zinc dissolves and is reprecipitated as very fine crystals; this is attributed to the metastability of the α-phase at the temperatures in question. From e.m.f. data on 2-phase amalgams heats of solution were calculated. The solid phase in these experiments could be largely freed from mercury by centrifugation, and was found to consist of hexagonal plates and prisms rounded by stirring.

1372 ON THE STRUCTURE OF ICE-FORMING NUCLEI.

R.Sänger.

Z. angew. Math. Phys.(Switzerland), Vol. 7, No. 3, 213-18 (May 25, 1956).

Gives a short discussion of epitaxy and electric double layer theories of the action of ice-forming nuclei. D.G.Holloway

1373 THE SEEDING OF ICE CRYSTALS WITH COPPER OXIDES AND COPPER SULPHIDES.

U.Katz.

Z. angew. Math. Phys. (Switzerland), Vol. 11, No. 3, 237-44 (May 25, 1960). In German.

The nucleability of the seeding substance is measured as a function of temperature by injecting it into a supercooled cloud. The number of ice crystals is estimated and the size distribution and number of injected particles are determined. Discrepancies with other work and comparison with theory is qualitatively discussed.

J.E.Caffyn

1374 FREE AND FORCED GROWTH ORIENTATION DURING THE GROWTH OF FERRITE SINGLE CRYSTALS.

U.Rösler and G.Elbinger.

Ann. Phys. (Germany), Vol. 6, No. 5-6, 236-40 (1960). In German.

The orientation of single crystals of Ni, Mg and Mg—Mn ferrites was observed by back reflection, the specimens being prepared by the Verneuil method with or without a seed crystal.

E.P.Wohlfarth

1375 THE EFFECT OF SMALL ZINC ADDITIONS ON THE PREFERRED ORIENTATION OF ALUMINIUM CRYSTALS GROWN OUT OF A MELT.

D.I.Lainer, R.L.Petruševich and E.S.Sollertinskaya.

Fiz. Metallov i Metallovedenie (USSR), Vol. 9, No. 4, 535-41 (April, 1960). In Russian.

Crystals of pure (99.99%) Al, grown by Czochralski's method, were found to grow preferentially in the [100], [111] and [110] directions, in this order of preference. In the case of Al containing 0.2% Zn, the [111] direction was invariably the preferred orientation of crystal growth. The results obtained were in agreement with the previously formulated theory of crystal growth, and confirmed the postulated selective adsorption of Zn on the (111) planes of Al crystals. M.H.Sloboda

1376 DOUBLE TWINNING AND CRYSTAL ORIENTATION.

Y.N.Trehan and A.Goswami.

Proc. Nat. Inst. Sci. India A, Vol. 25, No. 4, 210-13 (July 26, 1959).

The role of double twinning phenomena in the change of crystal orientations during crystal growth is emphasized. The indices of newer planes becoming parallel to known planes of the parent crystal, as a result of twinning, are deduced from the geometry of the twinned crystallites. Illustrations are cited where the new orientations of the deposit crystals are well explained on the above basis.

1377 THE GROWTH OF BISMUTH SINGLE CRYSTALS BY PULLING.

J.E.Packman.

J. Inst. Metals (GB), Vol. 89, Pt 3, 112 (Nov., 1960).

Crystals were pulled from the melt under a vacuum of $< 2 \times 10^{-2}$ mm Hg and a preference for the crystals to grow with the $\langle 111 \rangle$ axis normal to the growth axis was noted. A graph gives the experimental results relating the steady growth diameter to melt temperature. W.Bardsle

1378 A METHOD OF GROWING DISLOCATION-FREE GERMANIUM CRYSTALS.

B.Okkerse.

Philips tech. Rev. (Netherlands), Vol. 21, No. 11, 340-5 (1959-60).

Dislocation-free germanium crystals can be produced by pullin if the diameter of the crystal grown from the seed is initially reduced to 1 or 2 mm. This diameter is maintained over a length of about 20 mm, after which it is gradually raised to the desired value. In the thin neck of crystal thus produced, the dislocations present tend to intersect the surface at the place where they end; thermal stresses are too small to generate fresh dislocations. The thermal stresses generally increase as the crystal diameter is increased but no dislocations are created because of the absence of sources. However, should a piece of solid material floating on the melt come into contact with the growing crystal, dislocation sources are produced in the surface. Freedom from dislocations is demonstrated by the etch-pit method. Dislocation-free single crystals still contai point defects.

1379 GROWTH OF SEEDED ALUMINUM CRYSTALS OF IRREGULAR SHAPE.

T.H.Alden.

Rev. sci. Instrum. (USA), Vol. 31, No. 8, 897-8 (Aug., 1960).

Machined Al bars of the required shape were held in powder moulds and carefully melted to a seed. Details are given of the furnace and of growth procedure. J.Frank

1380 PARTICLE GROWTH DURING ZINC SULFIDE PHOSPHOR PREPARATION.

A.Kremheller and S.Fari

J. Electrochem. Soc. (USA), Vol. 107, No. 11, 891-5 (Nov., 1960).

The influence of processing conditions, such as time and temperature, and the effect of fluxing agents on the particle size and concomitant properties observed during zinc sulphide phosphor preparation are reported. The particle size increases exponentiall with the reciprocal firing temperature and as the square root of the firing time when phosphors are prepared in open boats; the activati energy and frequency constant depend on the flux employed. A particle size anomaly is observed when zinc sulphide powder containing zinc chloride is processed near 1000°C in sealed quartz vial his anomaly, which can be ascribed to the Hedvall effect, is accom- anied by anomalies in chloride retention and crystal structure.

INCORPORATION OF Au INTO VAPOUR-GROWN Ge.
ee Abstr. 1060

1381 PURIFICATION FACTOR CHARACTERIZATION OF ZONE REFINING. L.Gold and V.Johnson.
. Franklin Inst. (USA), Vol. 270, No. 5, 367-81 (Nov., 1960).

A quantity π_T, termed the purification factor, defines the poten- al state of purity realizable in a specimen that has undergone zone-efinement treatment. An exact analysis appears intractable, but eglect of the terminal zone perturbation (which becomes vanishingly mall for the infinite ingot) allows a lower bound to be established n the remanent solute impurity. Numerical values of π_T are valuated for some sensible distribution coefficients and zone imensions involving a maximum of ten passes. An expression for he solute impurity distribution is deduced and numerically appraised or a range of operational conditions not presently tabulated; the elation has been applied to the indicated π_T determinations.

1382 ELECTRICAL ANALOGUE IN THE STUDY OF THE TREATMENT OF AN INGOT BY THE MOLTEN ZONE IETHOD. F.Bertein.
. Phys. Radium (France), Vol. 19, Suppl. No. 12, 182A-183A (Dec., 958). In French.

A circuit is described by which impurity concentration distri- utions after zone melting can be obtained, from the original dis- ribution. J.Franks

1383 PHOTOGRAPHING AND PROJECTING CRYSTAL PATTERNS IN CONVERGENT POLARIZED LIGHT.
.H.Burns and M.A.Jeppesen.
.mer. J. Phys., Vol. 28, No. 9, 774-6 (Dec., 1960).

Procedures and inexpensive apparatus are described for photo- raphing and projecting patterns formed by crystals in convergent olarized light. The methods are especially suitable for wide-angle atterns such as those formed by mica. Illustrations are given.

CRYSTAL LATTICE STRUCTURES

1384 MOLECULES IN CRYSTALS.
D.Hodgkin.
Nature (GB), Vol. 188, 441-7 (Nov. 5, 1960).

A lecture delivered on the occasion of the Royal Society Tercentenary celebrations in July, 1960. A discussion of some of he early ideas on the nature of crystals is followed by an account f the application of X-ray diffraction to the study of molecular rystals. The techniques and results are illustrated by reference o many structures, including the following substances; the alums, enzene, diketopiperazine, epilimonol iodoacetate, vitamin B_{12}, roteins. J.Iball

1385 ON THE CONSTRUCTION OF THE LATTICE OF IONIC CRYSTALS FROM THE VIEWPOINT OF CLOSE PACKING. II. AX_2. K.Sasvári.
.cta phys. Hungar., Vol. 11, No. 4, 353-90 (1960).

For Pt I (type AX crystals) see Abstr. 16305 of 1960. The aper deals with the construction of crystal lattices of ionic com- ounds of composition AX_2 based on close packing. If the ratio of the onic radii satisfies the inequality $r_A/r_X \geq 0.732$, then the construc- on is very similar to that of CsCl and the lattice is built up from lose-packed ionic planes which contain both the anions and cations, espectively, in the adequate ratio. In this case only one solution is ossible, namely the CaF_2 lattice. If the ratio of the ionic radii atisfies the inequality $0.732 \geq r_A/r_X \geq 0.414$ the solution can be ound by investigating several possibilities of uniform cationic istributions in the octahedral cavities of the different spatial close- acked anionic frames which satisfy Pauling's coordination principle. Many such solutions can be found, several of them giving the lattice f rutile and its sister lattices with different chemical composition nd cationic distribution, the lattice of brookite and anatase. How- ver, no actual crystal lattices have been found till now, corres- onding to some of the possibilities. The actual crystal lattices are .most always distorted and dilated compared to the ideal ones uilt by close packing, but for isotypic lattices forming a group the fference volume associated with one anion has to be the same. With this supposition the author was able to show that a deviation from this rule occurs in the crystal lattices of compounds AB_2X_6 when the divalent A cations are Fe, Co, Ni or Mn. The most serious deviation can be found in the case of Fe. Another deviation can be found in the compounds AAs_2O_6 which has to be attributed to the influence of As^{5+} causing an apparent decrease of the ionic radii of the divalent cations A.

1386 SUPER-CELL STRUCTURE OF SEMICONDUCTORS.
B.R.Pamplin.
Nature (GB), Vol. 188, 136-7 (Oct. 8, 1960).

A new line of attack is proposed on the problem of listing the possible superlattice of the cubic lattice. Unit cells of superlattices based on a given lattice are called super-cells of that lattice, and this concept is illustrated with reference to the adamantine super-cells assuming that the available atomic sites are those of a diamond structure. Super-cells may be used to predict compositions at which ordering may occur and also to examine alternative structures. W.Bardsley

1387 CHEMICAL BINDING IN CRYSTALS WITH THE DO_3-(BiF_3)-STRUCTURE. O.G.Folberth.
Z. Naturforsch. (Germany), Vol. 15a, No. 8, 739-40 (Aug., 1960). In German.

A discussion of the effects of ionic size and geometry in the crystals which are of the type represented by BiF_3. In compounds AB_3 the type of lattice depends essentially on the ratio of the radii of the respective ions. If $S = R(A^{3-})/R(B^+)$ is less than 4, a lattice of the type DO_{18} is most stable, whereas if S is greater than 4, a DO_3 lattice appears. With $SbLi_3$ where S is approximately equal to 4, the compound is dimorphic and both types of lattice appear. The effects of ionic charge and of change from polar to metallic binding are considered. In addition, the role of the tetrahedral and octahedral spaces which appear within a face-centred cubic arrangement of close-packed large ions is discussed. The DO_3 structure appears when large anions (or cations) are in a ratio of 1 : 3 with small cations (or anions). The small ions fill the tetrahedral and octahedral spaces between the large ions. This is the packing with lowest energy. J.Iball

1388 A VERSATILE 19 cm DIAMETER LOW TEMPERATURE DEBYE—SCHERRER CAMERA. A.Taylor.
Appl. Spectrosc. (USA), Vol. 14, No. 5, 116-18 (1960).

The camera is designed for use with typical cylindrical powder specimens and also for bulky specimens. Partly on account of its large radius, it is capable of yielding high spectral resolution and lattice parameters to an accuracy of approximately 0.002% in favourable cases. In its present form, the camera may be used with the specimen in the temperature range -190° to $+200^\circ$C.

1389 X-RAY CAMERA FOR STUDY OF CRYSTALS AT LOW TEMPERATURES. M.A.Viswamitra.
Proc. Indian Acad. Sci. A, Vol. 49, No. 6, 326-32 (June, 1959).

The design of a compact constant temperature chamber which can be used for X-ray studies of thermal properties of crystals at any steady temperature between -185° and $+200^\circ$C is described. The adaptation of this thermostat for taking Laue, oscillation and back reflection photographs is also described. The advantages and disadvantages of the present design are discussed in detail.

1390 AN X-RAY DIFFRACTOMETER FOR SINGLE CRYSTALS.
J.L.Amorós, M.L.Canut, A.de Acha, M.Moreno and M.Guibert.
Rev. Cienc. apl. (Spain), Vol. 14, No. 75 289-302 (July-Aug., 1960). In Spanish.

Fairly detailed diagrams and descriptions are given of the goniometer and the stabilizer circuit for the X-ray generator, together with notes on the counter and the monochromator. The adjustment and use of the instrument are described. A.R.Stokes

1391 A CIRCULAR-ARC-SHAPED SLIT WITH FIXED CENTER AND CONTINUOUSLY ADJUSTABLE RADIUS FOR THE ANALYSIS OF CIRCULARLY SYMMETRIC LOW-ANGLE X-RAY DIFFRACTION PATTERNS. J.W.M.DuMond and J.Everitt.
Ann. Phys. (USA), Vol. 11, No. 1, 49-64 (Sept., 1960).

It is shown that a slit bounded by two appropriately chosen logarithmic spirals can be rotated and translated in front of a circular sector V-shaped opening with such a motion that the exposed segment of spiral slit at all times furnishes a good approximation to a circular arc with centre fixed at the point of the "V" and with continuously variable radius of curvature, the maximum radius being 10 times the minimum radius. The slit may be constructed so that its radial width remains at all times the same percentage of the radius so as to afford a total slit area varying as the square of the radius. The advantage in the quantitative scanning of circular diffraction patterns whose intensities frequently fall off rapidly with radius is obvious. Photographs of such a slit, constructed of metal by photolithographic etching process with a maximum radius of 2.8 cm and a minimum radius of 2.8 mm are shown and the method of construction is described.

1392 A LETTER TO THE EDITOR OF "FIZIKA TVERDOGO TELA". S.L.Nudel'man.

Fiz. tverdogo Tela (USSR), Vol. 2, No. 10, 2637-8 (Oct., 1960). In Russian.

Contains extensive corrections to the author's earlier work (Abstr. 18340 of 1960) on a graphical method of indexing X-ray diffraction patterns of triclinic crystals. [English translation in: Soviet Physics—Solid State (USA)]. A.Tybulewicz

1393 THEORY OF THE ANOMALOUS DISPERSION METHOD OF DETERMINING THE STRUCTURE AND ABSOLUTE CONFIGURATION OF NON-CENTROSYMMETRIC CRYSTALS.

S.Raman.

Proc. Indian Acad. Sci. A, Vol. 50, No. 2, 95-107 (Aug., 1959).

It is possible to determine the phases of X-ray reflections given by a non-centrosymmetric crystal, provided it contains an atom or a group of atoms which exhibit anomalous dispersion for the incident X-radiation. Both the change in the real part ($\Delta f'$) as well as the presence of the imaginary part ($i\Delta f''$) in the scattering power can be used for this purpose — either one alone or both together. In the former case, the phase determination is ambigouus but it becomes unique if both are used. Still more general methods may be considered, using two or three different wavelengths and also combining this technique with the isomorphous replacement technique — single or double replacement. All these methods are discussed and their relative merits are pointed out.

1394 ON THE ARBITRARILY CHOSEN SIGNS IN DIRECT METHODS FOR SOLVING CRYSTAL STRUCTURES.

N.V.Belov, S.V.Borisov and V.P.Golovachev.

Proc. Nat. Inst. Sci. India A, Vol. 25, No. 4, 220-9 (July 25, 1959).

Discussion and tabulation of those limitations regarding the arbitrary choice of three structure amplitudes which are introduced by the utilization in the direct methods of analysis of another symmetry, besides the inversion.

1395 THE STRUCTURE OF BISMUTH AT LOW TEMPERATURES. C.S.Barrett.

Austral. J. Phys., Vol. 13, No. 2a, 209-22 (July, 1960).

Solid State Physics Conference (see Abstr. 17864 of 1960). A precision determination of the displacement parameter of zone-refined bismuth containing less than 0.3 parts per million of spectroscopically detectable impurity was carried out as a function of temperature. Procedures were used that minimize uncertainties in integrated intensities due to extinction, absorption, temperature factor, dispersion and f-curve errors, and statistical errors. The parametre b/d, where d is the spacing of the (111) rhombohedral planes of one-sub-lattice and b is the displacement, of the other sub-lattice (111) planes from these, is 0.40437 ± 0.00008 at 4.2°K, 0.40403 ± 0.00008 at 78°K, and 0.4041 ± 0.0005 at 296 ± 2°K; the rhombohedral parametre, u, corresponding to these values is, respectively, 0.23406, 0.23400, and 0.23401. The small but presumably significant dependence on temperature at low temperatures is in disagreement with predictions of a theory of Blount and Cohen and may signify a lessening of resistance to the atom displacement from simple cubic, due to thermal expansion of the structure. Powder patterns yielded 57.31_4, 57.28_6, and 57.23_6° for the rhombohedral angle at 4.2, 78, and 304°K respectively.

1396 VARIATION OF THE TEMPERATURE COEFFICIENT OF THE INTENSITY OF X-RAY LINES OF COBALT DUE TO DISSOLUTION OF TUNGSTEN CARBIDE.

A.E.Koval'skii and L.Kh.Pivovarov.

Fiz. Metallov i Metallovedenie (USSR), Vol. 9, No. 4, 626-7 (April, 1960). In Russian.

The intensity, I, of X-ray diffraction lines of pure Co and Co-rich solid solutions containing WC, W, or C, was measured at room temperature and at 300°C. The $I_{300°}/I_{20°}$ ratio decreased with increasing quantity of dissolved WC or C. M.H.Sloboda

1397 NIOBIUM MONOCARBIDE.

E.K.Storms, N.H.Krikorian and C.P.Kempter.

Analyt. Chem. (USA), Vol. 32, No. 12, 1722 (Nov., 1960).

A mixture of -325 mesh graphite and niobium was prepared by tumbling, fired in a graphite crucible at 2300°C for 3 hr, reground to pass 325 mesh, and refired at 1860°C for 65 hr in vacuo. The resulting material had an empirical formula $NbC_{0.993}$. X-ray powder diffraction photographs were taken with a 114.59 mm camer A table is given of the indexed d spacings and relative intensities. The unit-cell is NaCl type, with a lattice constant a = 4.47095 ± 0.00009 A at 25°C. The theoretical density is 7.79 gm/cm³, and the Nb—C distance for 6-fold co-ordination is 2.2355 A. R.V.Coate

1398 AN X-RAY INVESTIGATION OF POLYMORPHISM IN Nb_2O_5. R.A.Zvinchuk.

Kristallografiya (USSR), Vol. 3, No. 6, 744-7 (Nov.-Dec., 1958). In Russian. English translation in: Soviet Physics—Crystallography (USA), Vol. 3, No. 6, 750-3 (Jan., 1960).

Nb_2O_5 crystal aggregates, prepared on a heated platinum filament at 1100-1300°C from the reaction $2NbCl + 5H_2O \rightarrow Nb_2O_5 + 10$ gave powder photographs similar to the α- and β-forms of Brauer (Zietschrift für anorganische und allgemeine Chemie, 248, 1, 1941), and annealing at 1450°C produced the α-form. The oxide heated at 1400° and 900°C gave different powder photographs; the latter (β-Nb_2O_5) was indexed on the assumption of a pseudo-hexagonal monoclinic cell. The mutual orientation of the crystals in the aggregates was also examined using a de Jonge and Bouman type X-ray camera. J.E.Caffy

1399 PREPARATION AND CRYSTAL STRUCTURES OF RuC AND OsC. C.P.Kempter and M.R.Nadler.

J. chem. Phys. (USA), Vol. 33, No. 5, 1580-1 (Nov., 1960).

X-ray powder data were obtained for RuC and OsC. The hexagonal unit cells had the following dimensions:

	a_0	c_0	c_0/a_0
RuC	2.9078_5 A	2.8218_6 A	0.9704
OsC	2.9076_9 A	2.8218_2 A	0.9705

J.Thewlis

NEUTRON DIFFRACTION STUDIES OF CHROMIUM-MODIFIE Mn_2Sb. See Abstr. 1242

1400 THE STRUCTURE OF BARIUM DITHIONATE DIHYDRATE. IV. REFINEMENT OF THE (010) PROJECTION. S.Martínez Carrera and S.García-Blanco Gutierre

An. Real. Soc. Espan. Fis. Quim. (Spain), Vol. 55 (A), No. 9-10, 233-40 (Sept.-Oct., 1959). In Spanish.

From new data, obtained with molybdenum radiation, a differen Fourier projection was made, from which the structure was refined Atomic positions are given. A.R.Stoke

1401 X-RAY STUDY ON THE MOLECULAR ROTATION IN CUBIC AMMONIUM NITRATE. Y.Shinnaka.

J. Phys. Soc. Japan, Vol. 14, No. 8, 1073-83 (Aug., 1959).

Ammonium nitrate can exist in five crystal modifications. The cubic form is stable between 125.2°C and the melting point (169°C) At 140°C the unit cell parameter is 4.37A, with one molecule per unit cell; thus the nitrate groups are rotating. A single crystal, prepared by slow cooling from the melt, was investigated with CuKα and MoKα radiation. It was assumed that the nitrate group is a planar equilateral triangle with N—O equal to 1.22 A. Statistically the centres of the NH_3 groups are at 0,0,0 and those of the NO_3 groups at $\frac{1}{2}, \frac{1}{2}, \frac{1}{2}$. On the basis of the observed structure factor for Bragg reflections the two most probable models of rotating NO groups are put forward. One is similar to that in the tetragonal modification and involves 12 equivalent configurations; the other is similar to that in the orthorhombic modification and this has 8 equivalent positions. A further study of the diffuse scattering was carried out and it is concluded that most of this arises from the disorder of the NO_3 groups and it would seem that of the two model indicated by the Bragg reflections the one with 12 equivalent configurations is more in accord with the experimental observations. The correlations between neighbouring rotating groups are considered in detail. J.Ibal

1402 THE EXPERIMENTAL STRUCTURE FACTORS OF TRIGONAL SODIUM NITRATE AND THE ATOMIC SCATTERING FACTORS OF THE SODIUM IONS. O.Inkinen.

Ann. Acad. Sci. Fennicae A VI (Finland), No. 55, 43 pp. (1960). In German.

The relative integral intensities of the diffraction lines of NO$_3$ were measured at 25°C in the interval $\sin\theta/\lambda = 0$ to 62 A^{-1}. The error in the structure factors calculated from the easured intensities was 0.6-1% for strong and medium reflections. e distance between N and O atoms in the NO_3 group was 224 ± 0.010 A. The atomic scattering factors of the Na ions were lculated for the reflections (hhh), (h00), (hh0) and ($h\bar{h}0$), the thermal otion of the Na ions was deduced to be ellipsoidal, with the largest nplitude in the direction of the trigonal axis, and the smallest nplitude at right angles. No deformation of the electron shells of ions in the $NaNO_3$ crystal was detected. J.Franks

1403 CRYSTALLOGRAPHIC DATA ON BETA-$Sr_2P_2O_7$.

C.W.W.Hoffman and R.W.Mooney.

Electrochem. Soc. (USA), Vol. 107, No. 10, 854-5 (Oct., 1960).

A sample of β-$Sr_2P_2O_7$ was prepared by heating $SrHPO_4$ for everal hours at 650°C. It was possible to index the X-ray diffraction powder diagram on the basis of a tetragonal unit cell with = 6.920 A, c = 24.79 A. A more refined list of d-spacings and served intensities is given [see Ropp et al., Analyt. Chem. SA), Vol. 31, 1163 (1959)]. The calculated density is 3.91 g cm^{-3} ith 8 molecules per unit cell, and the observed density was 86 g cm^{-3}. In view of the marked similarity with the powder agram of β-$Ca_2P_2O_7$ it is likely that the space group is $P4_1$. J.Iball

1404 THE CRYSTAL STRUCTURE OF Tl_2SO_4 AND Tl_2SeO_4.

G.Gattow.

aturwissenschaften (Germany), Vol. 47, No. 19, 442-3 (1960). In erman.

Crystals of Tl_2SO_4 and Tl_2SeO_4 were obtained by reacting $_2CO_3$ with H_2SO_4 and H_2SeO_4 respectively, and recrystallizing om aqueous solutions. Both compounds are orthorhombic. For $_2SO_4$; a = 7.808 ± 0.007, b = 10.665 ± 0.010, c = 5.929 ± 0.007 A; ensity (obs. 25°C) = 6.77 ± 0.02 g/cm^3, density (calc.) = 6.791 g/cm^3, mol./unit cell. For Tl_2SeO_4; a = 7.938 ± 0.007, b = 10.938 ± 0.010, = 6.255 ± 0.005 A; density (obs. 25°C) = 6.77 ± 0.02 g/cm^2, ensity (calc.) = 6.750 g/cm^3, 4 mol./ unit cell. The possible space oups are Pnam and $Pna2_1$ but comparison with other similar compounds indicates that the former is the most probable. J.Iball

1405 THE RESULTS OF A PRELIMINARY EXAMINATION OF SAMPLES OF $Pb(Nb_{0.5}Sc_{0.5})O_3$ and $Pb(Ta_{0.5}Sc_{0.5})O_3$.

G.Ismailzade.

ristallografiya (USSR), Vol. 4, No. 3, 417-19 (May-June, 1959). Russian. English translation in: Soviet Physics—Crystallography SA), Vol. 4, No. 3, 389-90 (March, 1960).

Reports the preliminary findings of an X-ray structural investiation of polycrystalline samples of these compounds, which are ew ferroelectrics with Curie points of 90° and 26°C. Both crystalze in the perovskite-type structure. Besides the principal lines of is structure, other superstructural lines appear. W.Bardsley

ALLOYS . METALLURGY

1406 THE ANALYSIS OF THE CRYSTALLOGRAPHY OF MARTENSITIC TRANSFORMATIONS BY THE METHOD F PRISM MATCHING.

B.A.Bilby and F.C.Frank.

cta metallurgica (Internat.), Vol. 8, No. 4, 239-48 (April, 1960).

A method of analysing the crystallographic features of martensi transformations by considering the matching of triangular prisms rmed by lattice lines in the two structures is described. The eory is illustrated by a detailed application to the martensitic ansformation observed in an iron nickel alloy by Greninger and oiano. The method is compared with other equivalent treatments d its advantages and disadvantages are discussed.

1407 NEW COMPLEX PHASE IN THE COPPER—GOLD SYSTEM.

R.E.Scott.

appl. Phys. (USA), Vol. 31, No. 12, 2112-17 (Dec., 1960).

At the composition 31.6 at% gold, the equilibrium diagram shows two-phase mixture of ordered and disordered material extending om 320°C to 350°C. However, a long anneal in this interval results an X-ray pattern showing superstructure reflections with strong tellites. The satellite pattern is obtained both by lowering and ising the temperature, and hence is believed to represent an uilibrium structure. The satellite pattern is interpreted in terms of a Cu_3Au II type structure, which is derived from the ordered Cu_3Au I by introducing antiphase domain displacements $(a_2 + a_3)/2$ at regular intervals along the a_1 axis, exactly analogous to the development of CuAu II from CuAu I. At 31.6 at % gold, the period is $18a_1$ ($9a_1$ between consecutive domain boundaries). Between 320°C and 335°C, there is a two-phase mixture of Cu_3Au I and Cu_3Au II. From 335°C to about 345°C the structure is that of Cu_3Au II. From about 345°C to 350°C there is probably a two-phase mixture of Cu_3Au II and disordered material, but this has not been established. The satellite pattern is also obtained at the composition 29.2 at% gold, and it is likely that the Cu_3Au II type structure exists over a range of compositions on the gold-rich side of Cu_3Au.

1408 THE LATTICE SPACING RELATIONSHIPS IN CLOSE-PACKED α AND ζ PHASES BASED ON GOLD.

T.B.Massalski and H.W.King.

Acta metallurgica (Internat.), Vol. 8, No. 10, 677-83 (Oct., 1960).

The lattice spacings of eight close-packed hexagonal ζ Au—Sn alloys and one Au—Hg alloy are reported and discussed as a function of composition and electron : atom ratio, using quenched alloys and X-ray powder methods. The results show that in the Au—Sn system the axial ratio and the a and c spacings change with increasing electron concentration in a similar manner to that observed earlier in Au—In alloys. Previously reported lattice spacing values in the α and ζ phase ranges for the four gold-based systems Au—Hg, Au—Cd, Au—In and Au—Sn are compared with the present work and discussed in terms of systematic deviations $\Delta a'$, $\Delta c'$ and Δa observed in all these alloys.

1409 LATTICE SPACING RELATIONSHIPS AND THE ELECTRONIC BAND STRUCTURE OF CLOSE-PACKED α AND ζ PHASES OF GOLD-BASED ALLOYS.

T.B.Massalski and H.W.King.

Acta metallurgica (Internat.), Vol. 8, No. 10, 684-90 (Oct., 1960).

The lattice spacing relationships in the α and ζ alloys based on gold are discussed in the light of previous similar studies. It is shown that the systematic deviations $\Delta a'$, $\Delta c'$, and Δa, observed in the lattice spacings of the ζ alloys, can be interpreted in terms of the interactions of the Fermi surface with the faces of the Brillouin zone of the c.p. hexagonal structure. When the present results are viewed in the light of the band structure theory they indicate that, similarly to the interpretation of Cohen and Heine, the Fermi surface must be considerably more distorted in the gold-based alloys than in alloys of copper or silver.

1410 NUCLEAR QUADRUPOLE COUPLING WITH CONDUCTION ELECTRONS IN CUBIC ALLOYS.

C.P.Flynn and E.F.W.Seymour.

Proc. Phys. Soc. (GB), Vol. 76, Pt 4, 526-31 (Oct. 1, 1960).

The coupling of the quadrupole moment of the solvent nuclei to the screening charge round an impurity is investigated by the partial wave treatment of conduction electron scattering. The magnitude of the interaction with the copper nuclei in the system CuZn is found to be an appreciable fraction of the experimental value obtained from nuclear resonance measurements.

1411 TRANSFORMATIONS IN THE β AND ζ PHASES OF THE SILVER—ZINC ALLOYS.

W.J.Kitchingman and J.I.Buckley.

Acta metallurgica (Internat.), Vol. 8, No. 6, 373-6 (June, 1960).

The mechanisms of the transformations $\zeta \rightleftharpoons \beta$ in a silver alloy of 49.97 at.% silver have been investigated by means of electrical resistivity measurements. Values obtained at various rates of heating and cooling in the temperature range 210°-340°C are given. The transformation $\zeta \rightarrow \beta$ takes place by breakdown of the ζ structure to give a partially ordered β structure which subsequently disorders. The transformation $\beta \rightarrow \zeta$ is accompanied by the formation of anti-phase domains.

1412 PHASE TRANSFORMATION DURING AGEING OF COPPER—TITANIUM ALLOYS.

E.G.Nesterenko and K.V.Chuistov.

Fiz. Metallov i Metallovedenie (USSR), Vol. 9, No. 3, 415-21 (March, 1960). In Russian.

X-ray investigation of polycrystalline 4.5% Ti—Cu alloy, aged at 450-700°C, revealed that an intermediate, metastable phase with a tetragonal lattice is formed in the course of decomposition of the solid solution. As a result of the formation of the α'-phase, so called because of the proximity of its lattice parameters (a = 3.691, c = 3.622 A) to that of the solid solution matrix (a = 3.620 A), type III distortions of considerable magnitude are produced in the solid solution lattice. It was also found that electrolytic extraction of the α'-phase affects neither its structure nor the lattice parameters. M.H.Sloboda

1413 X-RAY INVESTIGATION OF PHASE TRANSFORMATIONS IN ELECTRODEPOSITED MANGANESE.

V.P.Moiseev and O.S.Popova.
Fiz. Metallov i Metallovedenie (USSR), Vol. 9, No. 4, 584-8 (April, 1960). In Russian.

Mn can be electro-deposited in the form of both α and γ modifications. The latter is unstable and changes irreversibly after a few hours into the γ-modification, the transformation being accelerated by impurities whose presence in the electrolyte can completely suppress the deposition of α-Mn. In its final form, electro-deposited Mn is an interstitial solid solution of H in Mn with heavily distorted crystal lattice. On heating in vacuo, the solid solution decomposes and the lattice parameter decreases. When glycerol is added to the electrolyte, the H content in the deposit increases and the solid solution decomposes more readily on heating, whereby the formation of MnO on further heating is facilitated. Finally, steel in close contact with electrodeposited Mn can be retained in the austenitic condition even at room temperature. In addition to the experimental results, a formula is given with the aid of which the lattice parameters of cubic crystals can be calculated from the known indices of three X-ray lines and angles between these lines. M.H.Sloboda

1414 THE NATURE OF SUBGRAIN BOUNDARIES DUE TO PHASE TRANSFORMATION IN URANIUM.

R.W.Cahn and H.Tomlinson.
J. nuclear Materials (Internat), Vol. 2, No. 1, 88-9 (March, 1960).

The coherence between neighbouring pairs of subgrains in the α phase was studied. With the active slip-systems known, the nature of the expected misorientations across the sub-boundaries can be computed and compared with experiment. The role of four existing slip-systems was evaluated and the direction of a "rotation-axis" for one and two slip-systems involved discussed. The experimental X-ray results are shown in a figure. Within the margin of error half the axes lie in the expected zone [001] - [010]. These results confirm the hypothesis that subgrains in $\beta \rightarrow \alpha$ transformed uranium are due to a strain induced from the polygonization of glissile dislocations in the α-uranium lattice.

H.E.Schmid

1415 CHANGE OF PHASE AND DISORDERING OF THE COMPOUND U_2Mo BY IRRADIATION. J.Bloch.

J. nuclear Materials (Internat.), Vol. 2, No. 1, 90-1 (March, 1960). In French.

With samples of U_2Mo containing the b.c. tetragonal γ' phase the effects of thermal neutrons in the range 10^{16} - 1.2×10^{18} n/cm^2 were studied. The phase transition from γ' to γ was examined by an X-ray method. The relative intensity versus irradiation is shown in a figure. The changing of lattice parameters with irradiation from b.c. tetragonal γ' to b.c.c.γ is continuous. At no moment did there simultaneously exist the X-ray pattern of both lattices, which would show the formation of small "transformation cells" or a temperature distribution where some points was below the transformation temperature. The transformation begins with an irradiation of 10^{16} n/cm^2 and finishes with 1.2×10^{18} n/cm^2.

H.E.Schmid

1416 ELECTRON MICROSCOPE INVESTIGATION OF THE STRUCTURAL TRANSFORMATIONS IN THE TITANIUM-MANGANESE AND TITANIUM-CHROMIUM ALLOYS.

R.M.Lerinman, T.V.Shchegoleva, S.A.Kushakevich and S.I.Selitskaya.
Fiz. Metallov i Metallovedenie (USSR), Vol. 9, No. 3, 437-40 (March, 1960). In Russian.

The transformation of the β-phase in the 10.5% Mn—Ti and 9.4% Cr—Ti alloys containing approximately 0.1% Si, 0.05% N, 0.065% C, and 0.007—0.7% H, were studied by electron microscope examination of specimens, quenched from 850°C and aged at 400-550°C for 1-25 h. Ageing at 400°C resulted in the formation of highly dispersed lamellae (300-400 A thick) of the ω-phase. The presence of isolated, equiaxial lamellae of the ω-phase in both alloys indicated that this phase assumes the form of equiaxial lamellae already in the initial stages of its formation.

M.H.Sloboda

1417 SHORT- AND LONG-RANGE ORDER PARAMETERS IN DISORDERED SOLID SOLUTIONS. J.M.Cowley.

Phys. Rev. (USA), Vol. 120, No. 5, 1648-57 (Dec. 1, 1960).

For a crystalline solid made up of a partially ordered array of structural units of more than one type it is shown that the state of order may be described and defined in terms of the self-convolution, or Patterson, function of the structure. The peak heights of the Patterson function are proportional to the short-range order parameters, α_i. The periodic component is described by the long-range order parameters, defined as the limiting values of the α_i at large distances from the origin. The limitations of previous definitions of long-range order parameters are discussed. The interpretation of the Patterson function as a vector distribution function forms a basis for the calculation of configurational free energy and hence the derivation of equations giving the order parameters as functions of temperature. Some numerical results are obtained for short- and long-range order parameters for the alloys Cu_3Au and β-CuZn. For Cu_3Au, and for most other binary alloys, it is shown that two long-range order parameters, s_1 and s_2 are required to specify the state of long-range order, rather than the single parameter previously used. The fact that these two parameters are not simply related is interpreted as evidence for nonrandom fluctuations in the composition of the alloy, probably associated with the presence of out-of-phase domain boundaries which may be rich in one or other of the component types of atoms. It is suggested that a regular superlattice of out-of-phase domains may be present under equilibrium conditions for most alloys.

1418 ORDER—DISORDER PHENOMENA IN α-BRASS. I. DEVELOPMENT OF ORDER.

L.M.Clarebrough and M.H.Loretto.
Proc. Roy. Soc. A (GB), Vol. 257, 326-37 (Sept. 20, 1960).

An absorption of energy of 0.40 cal/g was observed in the range 180 to 245°C on heating a slowly cooled specimen of α-brass at 2°C/min. This absorption of energy increased markedly on isothermal annealing at temperatures below 190°C, the maximum absorption being 0.86 cal/g. The absorption of energy was correlated with changes in electrical resistivity and the results of the energy and resistivity measurements were attributed to the destruction of order. The experimental observations may be explained by the destruction of long-range order with a critical temperature of 245°C or by the destruction of short-range order, below 245°C, at a more rapid rate see also two following abstracts.

1419 ORDER—DISORDER PHENOMENA IN α-BRASS. II. INFLUENCE OF QUENCHING.

L.M.Clarebrough, M.E.Hargreaves and M.H.Loretto.
Proc. Roy. Soc. A (GB), Vol. 257, 338-62 (Sept. 20, 1960).

The transformation from disorder to partial order which occurs during slow cooling of α-brass (Pt I) may be suppressed by quenching. The return of order in specimens water-quenched from 300 and 600°C, on heating from room temperature to 300°C, studied by differential calorimetry and by measurements of electrical resistivity, density, lattice parameter and hardness. The results indicated that specimens quenched from 600°C reordered rapidly below 160°C to a higher degree of order than that in slowly cooled specimens. For specimens quenched from 300°C the initial degree of disorder was greater and reordering slower, the state characteristic of slowly cooled specimens being reached only at 245°C. The activation energies for reordering were 1.2 and 1.7 eV for specimens quenched from 600 and 300°C, respectively. The different behaviour after quenching from 600°C was attributed to a higher concentration of quenched-in vacancies. Neither set of specimens exhibited appreciable cooperative disordering. However, in specimens quenched from 600°C, reordered by heating to 160°C and then quenched, further ordering followed by equivalent disordering took place on reheating to 170°C. This process was probably vacancy assisted. The excess vacancies appeared to anneal out between 160 and 245°C, but any accompanying changes in properties were masked by order—disorder phenomena. No changes in hardness were found to accompany reordering in quenched specimens. See also preceding and following abstracts.

1420 ORDER—DISORDER PHENOMENA IN α-BRASS. III. INFLUENCE OF PLASTIC DEFORMATION.

L.M.Clarebrough, M.E.Hargreaves and M.H.Loretto.
Proc. Roy. Soc. A (GB), Vol. 257, 363-85 (Sept. 20, 1960).

The evolution of stored energy during heating for specimens of deformed α-brass was quite different from that previously observed for pure metals; the stored energy was much larger and at least three stages of evolution existed. These were studied for deformation in torsion and tension and the results correlated with measurements of electrical resistivity, density and hardness. The large release of energy in the first two stages was attributed mainly to the return of order destroyed by plastic deformation; the degree of disorder after heavy cold work was much greater than after quen-

hing (Pt II). However, slight deformation (10% tension) increased
he degree of order slightly. The first stage of energy release,
elow 120° C was probably due to rapid reordering assisted by
acancies created during deformation. The second stage represented
he bulk of the reordering and some recovery involving rearrange-
nent and annihilation of dislocations. The deformed specimens
vere probably strain-aged and thus recovery was accompanied by
he dispersal of atmospheres of zinc which increased resistivity and
ecreased density, to some extent counteracting the effects of reco-
ery. The balance of these three processes in stage 2 caused
omplex behaviour: the magnitude and even the sign of some changes
n properties varied with the deformation. Reordering was complete
efore the beginning of the third stage of further recovery and re-
rystallization, in which dispersal of atmospheres was again impor-
ant. Comparison of measurements of energy, resistivity and den-
ity suggested that the high concentration of stacking faults contri-
uted to the resistivity. Anneal hardening was observed for the
igher deformation and the maximum hardness coincided with the
naximum degree of order. See also two preceding abstracts.

1421 THE ORDERING OF THE SUBLATTICES OF A BINARY ALLOY. A.Corciovei.

tud. Cercetari Fiz. (Roumania), Vol. 10, No. 2, 277-90 (1959).
n Roumanian.

A centred cubic binary alloy is considered, having two com-
onents, A and B, in equal proportion. For complete order, the A
toms occupy the α lattice, given by the $\vec{a}_1$, $\vec{a}_2$, $\vec{a}_3$ basic vectors, the
 atoms occupy the complementary β lattice. The sublattice α_1,
efined by the basic vectors $\overrightarrow{2a}_1$, $\overrightarrow{2a}_2$, $\overrightarrow{2a}_3$, contains 1/z of the number
f points of the α lattice (z = coordination number). Long and short
ange order parameters for the α_1 sublattice and for its neigh-
ouring points, and also for the sublattice complementary to α_1,
ith respect to α, are studied. At the same time, a method for the
tudy of the order—disorder phenomena is given.

1422 MAKING A GRAIN STRUCTURE VISIBLE BY MEANS OF INTERFERENCE [-FORMING] EVAPORATED LAYERS.

.Pepperhoff.
aturwissenschaften (Germany), Vol. 47, No. 16, 375-6 (1960). In
erman.

A layer of TiO_2 deposited on the surface of a heat-treated
e—Cr—Ni—Si alloy shows up the two-phase structure by variations
 interference colours. A.R.Stokes

1423 THE FORMATION OF (110) [001] RECRYSTALLIZATION TEXTURE IN A COLD-ROLLED AND ANNEALED
10) [001] CRYSTAL OF SILICON-IRON. Hsun Hu.

cta metallurgica (Internat.), Vol. 8, No. 2, 124-6 (Feb., 1960).

Investigations of the rolling and recrystallization texture of 3%
—Fe crystals showed that the conclusions of other authors concern-
g the coherence between minor components of the deformation
xture having the same orientation as the initial crystal and the
crystallization texture could not be verified. Pole figures of cold
orked samples before and after annealing are shown. The results
dicate that annealing at low temperatures eliminates the orientation
atter around (110) [001] and that subsequent anneal at 950°C for
e minute produced a sharp (110) [001] recrystallization texture.
ne identical texture is obtained on annealing only at 800°C for 15
inutes without previous annealing at lower temperature. It
peared that the presence of a measurable minor (110) [001] com-
nent before final recrystallization is not a necessary condition for
e formation of a (110) [001] recrystallization texture.

H.E.Schmid

1424 DISCUSSION OF PAPER ENTITLED: "THE FORMATION OF (110) [001] RECRYSTALLIZATION TEXTURE IN
 COLD-ROLLED AND ANNEALED (110) [001] CRYSTAL OF
LICON-IRON" BY HSUN HU.

 L.Walter, W.R.Hibbard and C.G.Dunn.
 Acta metallurgica (Internat.), Vol. 8, No. 2, 126-7 (Feb., 1960).

 Addendum remarks concerning the mechanism of recrystalliza-
on (see previous abstract). The authors claim that in the cited
ork the pole figures shown after annealing of the crystal at lower
mperature should principally allow a modified mechanism during
ecrystallization. Further data and experimental work are neces-
ry to decide finally on the coherence between textures in a cold
olled and recrystallized crystal. H.E.Schmid

1425 ON THE PROBLEM OF THE MECHANISM OF FORMATION OF RECRYSTALLIZATION TEXTURES IN METALS AND ALLOYS. D.I.Lainer and E.I.Krupnikova-Perlina.

Fiz. Metallov i Metallovedenie (USSR), Vol. 9, No. 4, 542-4 (April, 1960). In Russian.

The mechanism of formation of preferred orientation in recrystallized metals was studied by X-ray analysis of Cu, Cu—Ni, and Cu—Ni—Mn—Si specimens, subjected to preliminary deformation of 96% and heat-treated under various conditions of time and temperature. It was shown that both oriented nucleation and oriented grain growth take place in the course of recrystallization, and that different degrees of recrystallization texture can be obtained by varying the conditions of heat treatment and/or the composition of the alloy. M.H.Sloboda

1426 A RESISTOMETRIC STUDY OF PRE-PRECIPITATION IN Al—10% ZN. C.Panseri and T.Federighi.

Acta metallurgica (Internat.), Vol. 8, No. 4, 217-38 (April, 1960).

An extensive investigation of the influence of quenching and aging temperatures upon the pre-precipitation phenomenon in Al-10% Zn was carried out by means of resistivity measurements at liquid nitrogen temperature. It was found that an appreciable clustering of solute atoms takes place during the quenching itself and that the rate of pre-precipitation during isochronal or isothermal aging increases greatly with quenching temperature; the energy of formation of vacancies in the alloy, evaluated by the dependence of the rate of clustering on the quenching temperature, is 0.70 ± 0.02 eV, as compared with the value 0.76 ± 0.04 eV previously reported for pure aluminium. The final size of zones during isothermal aging at 40°C is larger after quenching from 350°C and decreases both for lower and for higher quenching temperatures. The presence of a "slow reaction" after quenching from 600°C was also detected. Concerning the influence of aging temperature it was found that the amount of increase in resistivity decreases greatly by increasing the aging temperature and that the activation energies of the phenomenon (derived from the times to reach the maximum in resistivity) are 0.43 ± 0.02 eV after quenching from 300°C, and 0.38 ± 0.02 eV after quenching from 450°C. Other miscellaneous results on the effect of varying the aging temperature and on the reversion phenomenon are reported. The results are interpreted in terms of a simple picture of the pre-precipitation phenomenon; the role of vacancies appears to be a fundamental one in determining the rate of pre-precipitation which is stopped when all the excess of quenched-in vacancies is eliminated; the mechanism of elimination of vacancies appear to be, roughly, the same as in pure aluminium. The variation of the maximum increase in resistivity against the various aging temperatures has been explained in terms of a variation of the number of zones which form; in this way it appears that the number of zones is higher the lower the aging temperature, and that if the aging temperature is changed also the number of zones tends to change so as to establish the new equilibrium number; however this can be accomplished only if an excess of quenched-in vacancies is still present. Finally other related questions such as the reversion phenomenon, the "slow reaction" and the meaning of the activation energies are discussed.

1427 DISCONTINUOUS MODE OF DISSOLUTION OF A β PHASE PRECIPITATE INTO α Cu-Cd SOLID SOLUTIONS. M.S.Sulonen.

Acta metallurgica (Internat.), Vol. 8, No. 10, 669-76 (Oct., 1960).

A discontinuous mode of process apparently occurs, under certain circumstances, at dissolution of a solid phase into another. It has been found at dissolution of β precipitate into α Cu—Cd solid solutions and studied by metallographic and X-ray methods. The process occurs by formation of dissolved regions, nearly simultaneously, at all the matrix grain boundaries and growth of regions, at time-independent rate, into the grain interiors. The dependence of isothermally dissolved volume fraction x on solution time t agrees with a kinetic law of form $x = 1 - \exp(-Bt^{1.1})$, B being a parameter. The activation energy, Q, for growth resulting in complete dissolution is 21 kcal/g atom, which, together with some other data, suggests that the process is controlled by grain boundary diffusion along the transformation front. For growth in the $\alpha + \beta$ range Q is as high as 100-160 kcal/g atom which is explicable on the basis of the retarding effect of undissolved β on growth. The free energy relations and the origin of the driving force are also dicsussed.

1428 PRECIPITATION IN GOLD—PLATINUM ALLOYS. I. THERMODYNAMICS. L.J. van der Toorn and T.J.Tiedema.

Acta metallurgica (Internat.), Vol. 8, No. 10, 711-14 (Oct., 1960).

An expression is derived for the increase in the Gibbs' free energy which arises from the mixing of a total amount of 1 mole of the components of a binary system. The six constants of this expression are calculated for the gold—platinum system from experimental data. A comparison of this expression with those of other investigators is made.

1429 PRECIPITATION IN GOLD—PLATINUM ALLOYS. II. INFLUENCE OF THE SPINODAL CURVE ON THE RATE AND THE MECHANISM OF THE PRECIPITATION PROCESS.

L.J. van der Toorn.

Acta metallurgica (Internat.), Vol. 8, No. 10, 715-27 (Oct., 1960).

The influence of the spinodal curve on the rate and the mechanism of the precipitation process in gold—platinum alloys was studied by means of X-rays. An exposition is given of the theories of Borelius and Tichelaar and of the considerations put forward by Dehlinger et al. and Cohen. The experimental conditions of the present investigations are outlined, after which a description of the results is given with the aid of a large number of X-ray photographs. In the last part of the paper it is shown that although the theories of Borelius and Tichelaar roughly predict the observed phenomena, they probably require a modification because it may be expected that lattice imperfections play an important role in the precipitation process.

1430 EFFECTS OF COLD WORKING ON PRECIPITATION IN AGE-HARDENABLE ALLOYS.

Y.Murakami and O.Kawano.

Mem. Fac. Engng Kyoto Univ. (Japan), Vol. 21, Pt 4, 393-423 (Oct., 1959).

Experiments have been carried out to examine the effects of cold working on the rate of precipitation in high purity copper alloys and aluminium alloys with measurements of electrical resistance, micro-hardness and thermo-electromotive force, X-ray Laue photographs and small angle scatter method. The correlation between cold working and the excess vacancies retained in quenching was investigated in water quenched and air cooled specimens. The experiments provided evidence that cold working accelerates the process at higher ageing temperatures, and that at lower ageing temperatures the rate of precipitation of cold worked specimens is less than that of unworked materials. An Al—Ag and Al—Cu alloys, the formation of zones was hindered and the precipitation of the more stable intermediate phase γ' or θ' was accelerated. The suppressive effect of cold working is thought to be a general phenomenon in age-hardenable alloys, because the effect is also found in alloys such as Cu—Cr alloys in which the precipitation sequence is simple. The mechanism of retarding by cold working is due to two effects: one is the sweeping out of the quenched-in vacancies, which are necessary for solute diffusion, by the motion of jogs in dislocations during cold working, and the other is the formation of many smaller clusters of enriched solute atoms which were formed by the stronger binding interaction energies between solute atoms and the lattice defects introduced by cold working.

1431 RESEARCH ON THE STRUCTURE AND LOW-TEMPERATURE ANNEALING EFFECT IN COLD-ROLLED α-BRASS. I. STRUCTURE AND CHANGE IN HARDNESS.

O.Izumi.

Sci. Rep. Res. Insts Tohoku Univ. A (Japan), Vol. 11, No. 2, 120-30 (April, 1959).

The change in hardness by low-temperature annealing of cold-rolled 70/30 brasses having different ready-to-finish grain sizes (fine and coarse) and cold-rolled by different reductions (10~90%) was measured. The specimens were annealed at 150, 250, 350 and 450°C for 5 min~24 hrs. The hardness change by annealing was considered to be related to the structures as ready-to-finish annealed and as cold-rolled. It appears that the hardness does not vary simply with rolling reduction or grain size, but is more complicatedly influenced by the development degree of the rolling structure or by the condition of specimens such as the composition.

1432 RESEARCH ON THE STRUCTURE AND LOW-TEMPERATURE ANNEALING EFFECT IN COLD-ROLLED α-BRASS.II. STRUCTURES COLD-ROLLED AND ANNEALED AT LOW TEMPERATURES. O.Izumi.

Sci. Rep. Res. Insts Tohoku Univ. A (Japan), Vol. 11, No. 2, 131-44 (April, 1959).

The structure changes by cold-rolling and low-temperature annealing of 70/30 brass were examined by a microscope and X-ray photography. The difference in ready-to-finish grain size affected the degree of development of the rolling structure. A coarse-grained material tended to delay the development, compared with a fine-grained one. The tendency seemed to relate to the hardness change by low-temperature annealing as previously reported. No remarkable change in structure was observable by annealing at 150°C, while a kind of polygonization was seen at 250°C. Though the nucleation by recrystallization developed preferentially at the regions strained severely, grain growth was observed along the slip lines at 350°C. The difference in grain size affected the rate of recrystallization.

1433 ON THE STABILITY OF THE STRUCTURAL CONDITION RESULTING FROM ORDERING OF WORK-HARDENED ALLOY Fe_3Al. Ya.P.Selisskii.

Fiz. Metallov i Metallovedenie (USSR), Vol. 9, No. 3, 472-3 (March, 1960). In Russian.

Dilatometer measurements, carried out on Al—Fe alloys containing 19.9, 21.3, and 24.4 at.% Al in the annealed (heated to 850° C and quenched) and work-hardened (hot-worked at 650-700° C) condition, indicated that the structural condition resulting from ordering of a plastically deformed alloy is more stable than that produced by the disorder—order transformation taking place in a structure obtained by annealing and quenching. M.H.Sloboda

1434 A STUDY ON THE DISPERSION-STRENGTHENED STEEL. Y.Imai and H.Hirotani.

Sci. Rep. Res. Insts Tohoku Univ. A (Japan), Vol. 12, No. 2, 168-74 (April, 1960).

The dispersion-strengthening phenomenon in iron and steel was studied. The specimens were composed of powdered iron, ferritic or austenitic heat-resisting alloys, in which Al_2O_3, MgO or SiO_2 was dispersed. Changes in hardness during heating of cold-worked specimens with various compositions, and the results of tensile- and rupture-test at high temperatures clearly showed the dispersion-strengthening phenomenon.

1435 ON THE APPLICATIONS OF PHASE DIAGRAMS TO THE KNOWLEDGE OF THERMODYNAMIC INTERACTIONS. E.Bonnier and P.Desré.

C.R. Acad. Sci. (France), Vol. 251, No. 5, 706-8 (Aug. 1, 1960). In French.

In the case of monotectic alloys it is shown that the positive curvature of the liquidus at $x_A = 1$ indicates for nearly all alloys a tendency of the liquid constituents to separate. P.Gray

1436 ON THE PROBLEM OF THE CONSTITUTION DIAGRAM OF THE NICKEL—CHROMIUM SYSTEM.

B.M.Vasyutinskii, V.S.Kogan and G.N.Kartmazov.

Fiz. Metallov i Metallovedenie (USSR), Vol. 9, No. 4, 558-63 (April, 1960). In Russian.

Bimetal specimens, obtained by vacuum deposition of Cr on Ni substrates, were diffusion-annealed at 1250 and 1100°C, the annealing times (10 and 125 hr, respectively) having been chosen so as to ensure the same thickness of the diffused zone in each case. In agreement with the findings of other workers, the results of X-ray analysis, metallographic examination, and microhardness measurements indicated that at ~ 1200°C a eutectoid transformation (decomposition of the β phase, stable at high temperature) takes place in Ni—Cr alloys. M.H.Sloboda

1437 THERMODYNAMICS OF FORMATION OF COPPER—MAGNESIUM AND NICKEL—MAGNESIUM COMPOUNDS FROM VAPOR PRESSURE MEASUREMENTS.

J.F.Smith and J.L.Christian.

Acta metallurgica (Internat.), Vol. 8, No. 4, 249-55 (April, 1960).

The magnesium vapour pressures over Cu—Mg and Ni—Mg alloys have been measured by the Knudsen effusion method in the temperature range 400-1100°K. The free energies, enthalpies and entropies of formation of Mg_2Cu, $MgCu_2$, Mg_2Ni and $MgNi_2$ were computed from the vapour pressure data. The results indicate that the bond strengths in the Ni—Mg compounds are appreciably greater than in the corresponding Cu—Mg compounds.

1438 INTERMETALLIC PHASES IN THE ALUMINIUM—MANGANESE BINARY SYSTEM. M.A.Taylor.

Acta metallurgica (Internat.), Vol. 8, No. 4, 256-62 (April, 1960).

The region of the aluminium-manganese phase diagram from 33 to 45 wt% manganese investigated by means of X-ray analysis density measurements, and microsections. Two previously unknown intermetallic compounds were isolated, and a third known phase shown to be stable only at high temperatures. Crystallograph and chemical studies of the various phases are described, and corrections to the published phase diagram suggested.

1439 A CONTRIBUTION TO THE MECHANISM OF SULPHITATION OF Cu–Zn ALLOYS WITH LOW Zn-CONTENT.
Mikulski, S.Mrowec, I.Stroński and T.Werber.
ull. Acad. Polon. Sci. Ser. Sci. math. astron. phys. (Poland), Vol. 8, o. 5, 333-7 (1960). In German.

The sulphitation and the formation of a two-layer scale of u–Zn alloys in the range of 1-5 at.% Zn was investigated. Cleaned d etched surfaces were immersed into liquid sulphur at 444°C. adioactive sulphur (S^{35}) was added after a scale-layer of thickness 5 × 10^{-2} cm had formed, guaranteeing complete absorption of the ^{5} radiation. It is shown in a table that (1) diffusion of sulphur rough the scale drops with decreasing Zn content and is about zero 1.3 at.% Zn; (2) growing of the inner scale-layer is enabled by ecomposition at the boundary of the two layers under formation of ee sulphur that reacts with the surface; (3) with alloys of more an 4 at.% Zn the diffusion of sulphur to the surface was dominant.
H.E.Schmid

1440 IRREVERSIBLE, THERMALLY-INDUCED CHANGES OF THE SHAPE OF CADMIUM-LEAD AND CADMIUM-INC ALLOY [SPECIMENS].
.N.Davidenkov, V.A.Likhachev and G.A.Malȳgin.
iz. tverdogo Tela (USSR), Vol. 2, No. 10, 2450-4 (Oct., 1960). In ussian.

The concentration dependence of the irreversible, thermally-duced dimensional changes in two-phase alloys was studied. The d–Zn and Cd–Pb alloys, chosen for this purpose, represented ystems with either both components anisotropic (Cd–Zn) or one isotropic and one isotropic (Cd–Pb) in respect of their thermal xpansion coefficients. The results, obtained for the 15-165°C range, dicated that irreversible changes of this nature can occur in both pes of alloys. Owing to the interaction between the two phases resent, in neither system studied was the concentration dependence the effect linear. Consequently, it is not possible to predict the ehaviour of alloys of such systems even if the relevant properties their components are known. In principle, however, it is possible determine the composition of alloys which, in spite of anisotropic ermal expansion characteristics of one or both components, will ot be subject to irreversible dimensional changes due to thermal ycling, particularly if the service conditions can be accurately ontrolled. [English translation in: Soviet Physics–Solid State JSA)].
M.H.Sloboda

1441 THE THERMAL AND MAGNETIC PROPERTIES OF SOME TRANSITION ELEMENT ALLOYS.
W.Budworth, F.E.Hoare and J.Preston.
roc. Roy. Soc. A (GB), Vol. 257, 250-6 (Sept. 6, 1960).

Results of measurements of the magnetic susceptibilities of a ries of binary alloys are presented. The systems investigated ere Pd–Rh, Pt–Ir and Pt–Au. Certain similarities between the loys of palladium alloyed with silver or rhodium and those of atinum alloyed with gold or iridium are apparent. In addition, the ecific heats of palladium–rhodium and platinum–gold alloys were easured in the liquid-helium temperature range and the electronic ats and Debye temperatures computed. The overall picture presented by the results is consistent with the existence of an unfilled band, gaving approximately 0.6 holes per atom both for palladium d platinum, which may be filled by alloying with the element of xt highest atomic number. Recent work has shown, however, that is unlikely that the band shape is unchanged on alloying and therere the calculation by which the number of holes is obtained is probly invalid.

OTHER SOLID FORMS

1442 GROWTH OF CRYSTALS IN GLASS.
J.G.Morley.
rit. J. appl. Phys., Vol. 12, No. 1, 10-13 (Jan., 1961).

The devitrification characteristics of five Na_2O–SiO_2 glasses ve been examined by a new method, and some empirical relationips, applicable over the range of compositions studied, have been tablished. Comparisons are made with results given in other blished work.

SURFACE FLAWS IN GLASS. See Abstr. 1347

1443 STRUCTURE ANALYSIS OF SOME FUSED MATERIALS BY X-RAY DIFFRACTION. I. $NaNO_3$, $NaNO_2$ AND PbO-B_2O_3 SYSTEM. K.Furukawa.
Sci. Rep. Res. Insts Tohoku Univ. A (Japan), Vol. 12, No. 2, 150-67 (April, 1960).

A new method of X-ray diffraction measurement widely applicable to fused materials including corrosive substances up to high temperature ranges is described. By the Fourier analysis of X-ray diffraction data, the atomic radial distribution curves of several fused materials have been obtained. Fused $NaNO_3$ and $NaNO_2$ contain Na^+ ions and NO_3^- or NO_2^- radicals, which are in thermal motion being restricted by their specific shapes and charge distributions. The structure of fused PbO–B_2O_3 system in the range of PbO/B_2O_3 = 4/1 to 1/3 in mol-ratio are, in general, considerably similar to their glass, but Pb–O bonds become more ionic by the fusion or by the increase of B_2O_3 content. Its abnormal glass-forming-limit (94 wt % in PbO) is also explained.

1444 COMPARISON OF X-RAY AND NUCLEAR MAGNETIC RESONANCE MEASUREMENTS OF CRYSTALLINITY IN POLYETHYLENE TEREPHTHALATE.
G.Farrow and I.M.Ward.
Brit. J. appl. Phys., Vol. 11, No. 12, 543-6 (Dec., 1960)

Measurements were made over a wide temperature range on oriented and unoriented samples of polyethylene terephthalate. The results show that, although in general terms, no correlation exists between the two methods, above the glass transition a considerable proportion of the non-crystalline regions achieve molecular mobility. The n.m.r. method gives higher values of crystallinity than the X-ray method. This is apparently due to some of the non-crystalline material being immobilized owing to entanglements, and the presence of surrounding crystallites for this material will make a contribution to the broad component of the n.m.r. signal which is used as a measure of the crystalline fraction of the polymer.

1445 INTERDEPENDENCE OF PHYSICAL PROPERTIES OF POLYMERS. N.I.Vorob'ev.
Elektrichestvo (USSR), 1960, No. 3, 75-6 (March). In Russian.

Polymers (crystalline or amorphous) with greater intermolecular forces have also greater values of some physical properties (temperature of vitrification, melting point of crystal phase, softening point, modulus of elasticity, tensile strength, density, hardness, adhesion, degree of crystallinity, electric breakdown strength), but smaller values of other properties (coefficient of thermal expansion, elasticity, electric conductivity and permeability to moisture). This general regularity applies to all amorphous and many crystalline polymers, also to copolymers and some polymers with tridimensional structure, but not to silicon-organic and fluorine-organic polymers.
F.Lachman

1446 THE SINTERING OF URANIUM OXIDES.
J.Williams.
J. nuclear Materials (Internat.), Vol. 2, No. 1, 92-3 (March, 1960).

It is suggested that the failure of the French authors Bel et al. (see Abstr. 8464 of 1860) to detect any beneficial effect of departure from stoichiometry upon sintering behaviour in neutral atmospheres may have been due to the use of binders and lubricant. If molybdenum trays were used they would affect the result too. Data are presented to show that there is apparently little difference between the British and French "active" powders sintered in hydrogen. Attention is also drawn to the phenomenon of "over-sintering".
A.E.Kay

Surfaces . Films . Adsorption

1447 STRUCTURE AND ADSORPTION CHARACTERISTICS OF (111) AND $(11\bar{1})$ SURFACES OF InSb CLEANED BY ION BOMBARDMENT AND ANNEALING. D.Haneman.
J. Phys. Chem. Solids (GB), Vol. 14, 162-8 (July, 1960).

Low energy electron diffraction studies have been made of five (111) and $(11\bar{1})$ surfaces of InSn which were cleaned by argon ion bombardment and annealing. From the diffraction patterns obtained in both (110) and (112) azimuths, a double-spaced structure of surface atoms appears to be present on (111) and $(11\bar{1})$ surfaces. Exposure to oxygen resulted in a gradual decrease in intensity of all beams, indicating that an amorphous layer of oxygen was formed. The sticking coefficient for oxygen on the cleaned surface has a

1458 OXYGEN ON NICKEL.
L.H.Germer and C.D.Hartman.

J. appl. Phys. (USA), Vol. 31, No. 12, 2085-95 (Dec., 1960).

Low-energy electron diffraction, with the diffracted electrons post-accelerated and observed on a fluorescent screen, has been used to study the adsorption of oxygen on a (100) face of a nickel crystal. Upon admitting oxygen to a clean face at room temperature, or at elevated temperatures up to 350°C, the first adsorbed atoms are arranged in narrow bands parallel to [110] directions on the crystal surface. Within one of these bands, atoms lie on lines at right angles to the band; these lines have a uniform separation of 4.98 A, but the atoms along each line are somewhat randomly spaced in multiples of the nickel spacing of 2.39 A. With further oxygen exposure (30×10^{-6} mm Hg sec) sufficient to produce half of a monolayer (one oxygen atom for every four surface nickel atoms), the arrangement is very chaotic unless the crystal has been heated, but after heating the arrangement is a simple square array with edge of 4.98 A. Further exposure to oxygen (100×10^{-6} mm sec) will produce a full monolayer consisting of this same square array with an additional oxygen atom at the centre of each square. With still further exposure, oxygen, at least in part as physisorbed molecules, is piled on top of this first monolayer of atoms, the added molecules forming an array with square symmetry and edges parallel to the edges of the square array of surface nickel atoms. At least several layers of oxygen molecules can be adsorbed and are not removed by pumping at room temperature. Heating at 350°C removes a great deal of the adsorbed oxygen, and the structure of the remainder agrees with that of NiO having the orientation of the nickel crystal. This oxide is removed at 830°C, and the first layer of oxygen atoms at 880°C.

1459 THE CALORIMETRIC DETERMINATION OF THE HEATS OF ADSORPTION OF OXYGEN ON EVAPORATED METAL FILMS.
D.Brennan, D.O.Hayward and B.M.W.Trapnell.

Proc. Roy. Soc. A (GB), Vol. 256, 81-105 (May 31, 1960).

A Beeck-type calorimeter was used to measure the integral heat of adsorption of oxygen on evaporated films of titanium, chromium, manganese, iron, cobalt, nickel, niobium, molybdenum, rhodium, palladium, tantalum, tungsten, platinum and aluminium. The variation of the heat with the extent of the adsorption was also determined, except with palladium, platinum and aluminium, for which the amounts of oxygen adsorption were too small to allow this to be done. The heats of adsorption reported are based on a careful determination of the heat capacity of the calorimeter and the overall error is not more than ±5 kcal/mole. Some investigations of calorimetric behaviour were made. The surface areas of the films were measured before and after an adsorption by the B.E.T. method; krypton isotherms at −196°C were used for this purpose. From these data, it was possible to estimate the number of atoms of oxygen adsorbed per surface metal atom. In most cases, this quantity, together with the heat of adsorption, can be related to the oxygen—metal ratios and the heats of formation of certain oxides; this observation is remarkable in view of the limited extent of the adsorption. In the cases of rhodium, palladium and platinum the adsorption stops short of a monolayer and is probably true chemisorption rather than oxide formation. For those metals on which oxide formation occurs, the decrease in heat of adsorption with increasing coverage was interpreted, in general, in terms of an increase in the oxidation number of surface metal ions by electron transfer within the adsorbed layer. Some theoretical correlations between the heat of adsorption and the atomic and the bulk properties of the species concerned were examined and found of little value; an empirical relation with the metallic radius is given.

1460 INFRARED SPECTRA OF WATER SORBED ON SYNTHETIC ZEOLITES.
H.A.Szymanski, D.N.Stamires and G.R.Lynch.

J. Opt. Soc. Amer., Vol. 50, No. 12, 1323-36 (Dec., 1960).

The infrared spectra of water sorbed on several synthetic zeolites is discussed in terms of the molecular species present. Three different sets of bands are observed for water as the water content on the zeolite is varied. Evidence for surface OH groups for synthetic zeolites is presented. A technique for reducing the scattered light of zeolite powders by wetting them is suggested. It is possible to study surface OH groups by this technique using D_2O as the wetting agent. A mechanism whereby surface OH groups can form in sodium and ammonium zeolites is given. The results obtained for water sorbed on sodium zeolites differ to some extent from those reported previously.

1461 INFLUENCE OF GRAIN-SIZE ON THE RATE OF ABSORPTION OF HYDROGEN BY PALLADIUM.
T.J.Tiedema, B.C.De Jong and W.G.Burgers.

Proc. K. Ned. Akad. Wetensch. B. (Netherlands), Vol. 63, No. 4, 422-6 (1960).

Palladium wires of different grain-size, if charged under identical conditions with hydrogen gas, show a pronounced difference in the rate of absorption of the hydrogen, this difference being such that the smaller the grains the higher the rate of absorption. Most likely this difference is caused by a difference in rate of dissociation of the hydrogen molecules at the surface of the specimens. Probably the grain boundaries act as favoured places for this dissociation. An influence of the rate of internal diffusion could not be established. Palladium wires of different grain-size but charged with electrolytically produced hydrogen do not show a difference in rate of absorption.

MICROSTRUCTURE EXAMINATION

(By X-rays and Electron and Other Microscopes)

1462 REMARKS ON THE MICROSCOPIC OBSERVATION OF VERY FAINT SURFACE STEPS. A.R.Weill.

J. Phys. Radium (France), Vol. 19, Suppl. No. 12, 181A-182A (Dec., 1958). In French.

Microscopic observation of surfaces of SiC crystals were made with bright and dark field illumination, and the limits of resolution obtained for various magnifications. Nitrocellulose replicas of the surfaces showed steps of 15 A when examined by transmitted light, with reflected light the limit should be about 4 A. J.Franks

1463 FLUORESCENT SCANNING MICROSCOPY.
R.Bernard, F.Davoine and P.Pinard.

Optik (Germany), Vol. 17, No. 3, 129-34 (March, 1960). In German.

Collector-multiplier systems have been devised for the scanning electron microscope so that the image may be formed either from the scattered electrons or from photons by luminescen Filters have been used to separate narrow bands in the visible and u.v. regions of the luminescent spectrum. Comparative studies of the electron and luminescent images of ZnS, $CaWO_4$, NaCl and CdS give promising results. The luminescence is highly localized and its intensity and wavelength depend upon crystal defects. R.Ree

1464 THE DIRECT OBSERVATION OF METALLIC SURFACES IN THE ELECTRON MICROSCOPE.
K.Thomas and K.F.Hale.

Phil. Mag. (GB) (Eighth Ser.), Vol. 4, 531-2 (April, 1959).

The metal foil is varnished on both sides, leaving a "window" on one side only. The foil is then thinned by electrolytic polishing, the varnish preserving one original surface. Finally, the varnish is dissolved away. The surface detail thus retained aids the interpretation of dislocation arrays in the deformed metal. Examples are given of the use of this technique for 2% extended stainless steel, for fatigued specimens, and for crystallographic growths on pure aluminium annealed in vacuo. R.V.Coates

1465 DARK-FIELD ELECTRONMICROSCOPY AND ITS APPLICATION. T.Hibi and S.Takahashi.

Sci. Rep. Res. Insts Tohoku Univ. A (Japan), Vol. 11, No. 6, 490-507 (Dec., 1959).

A new method was used for dark-field electron microscopy. By using this method it was not only possible to obtain both bright-field and dark-field images without changing the position of the specimen but the lowering of the resolution was less serious than that of other methods. It was applied in the present study for dark-field electron microscopy of vaporization films, thin crystals and bacteria The dark-field images indicated important advantages in the use of the method.

1466 THERMALLY INDUCED CHANGES IN THIN FILMS IN THE ELECTRON MICROSCOPE. W.Lippert.

Z. Naturforsch. (Germany), Vol. 15a, No. 7, 612-15 (July, 1960). In German.

When irradiated with 60 kV electrons in the normal manner, the embedding materials Plexiglas and Vestopal W undergo considerabl loss of substance. Vestopal is the more resistant, retaining its for better at high temperatures and tolerating a loading of 3×10^{-4} A/cm^2. Plexiglas weakens at lower temperatures and becomes istic at 10^{-4} A/cm^2. Without special precautions the films can be stroyed completely but by using double condenser lens illumination, mperature rises can be minimized and both materials can be abilized against further loss of substance. R.Reed

1467 A NEW METHOD FOR DETERMINING THE HEIGHT OF PARTICLES (SPHERICAL CALOTTE) BY MEANS OF AN LECTRON MICROSCOPE. R.Grigorovici, N.Croitoru and A.Devenyi.
ıd. Cercetari Fiz. (Roumania), Vol. 9, No. 4, 505-9 (1958). In oumanian.

This new method is based on the precise determination of the adow-angle. Spherical goummi-goutte particles were deposited on e same support as the particles of the sample. Both types of particle are shadowed with gold; this makes it possible to measure the shadow-angle from the length of the shadow and the radius of the goummi-goutte. By knowing the shadow-angle and the section radius of the particle (spherical calotte) it is easy to calculate the height of the particle. For this purpose, the authors give a precise formula for the height.

OBSERVATIONS OF DISLOCATIONS IN METALS BY TRANSMISSION ELECTRON MICROSCOPY. See Abstr.970.

ELECTRON MICROSCOPE INVESTIGATION OF THE STRUCTURAL TRANSFORMATIONS IN THE TITANIUM—MANGANESE AND TITANIUM—CHROMIUM ALLOYS. See Abstr. 1416

PHYSICAL CHEMISTRY

1468 AUTOMATIC APPARATUS FOR MEASUREMENT OF THE RATE OF ABSORPTION OR EVOLUTION OF GAS.
Scanlan and J.R.Dunn.
sci. Instrum. (GB), Vol. 38, No. 1, 28-30 (Jan., 1961).

An apparatus is described in which constant pressure is aintained as gas is absorbed or evolved by changing that volume a threaded rod which is inside the apparatus. The change in lume of the gas is then equal to the change in volume of the rod side the apparatus. Use of an escapement to turn the screw rough constant-volume increments provides a simple method of tomation.

THERMOCHEMISTRY . REACTIONS

1469 NONMOLECULAR NATURE OF NITRIC-OXIDE-INHIBITED THERMAL DECOMPOSITION OF n-BUTANE.
.Kuppermann and J.G.Larson.
chem. Phys. (USA), Vol. 33, No. 4, 1264-5 (Oct., 1960).

About 10 cm Hg pressure of an equimolar mixture of n-butane nd n-butane-d_{10} was decomposed at 430° C (in the absence and resence of NO) to extents varying from 1% to 5%. The product- eactant mixture was analysed in a mass spectrometer. From the esults it is concluded that practically no ($< 2\%$) methane is formed a direct split mechanism in the NO-inhibited thermal decom- osition of n-butane. W.Good

1470 THE DISSOCIATION PRESSURE OF CdSb.
V.J.Silvestri.
phys. Chem. (USA), Vol. 64, No. 6, 826-7 (June, 1960).

The dissociation pressure has been measured in the tempera- re range 287-448° C employing a dew point technique. The Cd essure in equilibrium with solid broken single crystal CdSb was easured. The data can be represented by a straight line which fits e equation $\log P = 7200T^{-1}$ where P is the pressure in mm Hg, and is the absolute temperature in degrees K. W.Bardsley

1471 RATE OF REACTION OF NITROGEN ATOMS WITH ETHYLENE. J.T.Herron.
chem. Phys. (USA), Vol. 33, No. 4, 1273-4 (Oct., 1960).

The reaction was studied in a simple flow system at 27° C and 7° C, and with differential initial concentrations both of C_2H_4 and The disappearance of N atoms was found to be first order in th N and C_2H_4 concentrations at temperatures greater than 150° C. reaction mechanism is proposed. (The N was produced by partial ssociation of N_2 in an electrodeless discharge). W.Good

1472 THE KINETICS OF ISOMERIC REACTIONS.
R.O.Davies.
oc. Roy. Soc. A (GB), Vol. 257, 541-51 (Sept. 27, 1960).

A careful consideration of the kinetics of simple reacting stems near equilibrium shows that the observable relaxation nes of the system involve not only transition probabilities (or rate nstants) but also the dependence of these quantities on concen- tions. By using a new method to describe the kinetics of 2- and state processes (which introduces a time-dependent distribution ction for the reaction co-ordinates) it is shown that, under certain nditions, the concentration-dependent terms can be evaluated in ms of the solution properties of the system.

1473 STABILITY OF FLAME PROPAGATION.
G.I.Barenblatt and Ya.B.Zel'dovich.
Priklad. Mat. i. Mekh. (USSR), Vol. 21, No. 6, 856-9 (1957). In Russian.

Rosen's results (Abstr. 6558-9 of 1954) are criticized. It is shown that, under the conditions considered by Rosen, stability always exists.

1474 STRONG POINT-EXPLOSION IN A COMPRESSIBLE MEDIUM. N.N.Kochina and N.S.Mel'nikova.
Priklad. Mat. i Mekh. (USSR), Vol. 22, No. 1, 3-15 (1958). In Russian.

1475 HYDROGEN—DEUTERIUM EXCHANGE IN FUSED SILICA. D.L.Fry, P.V.Mohan and R.W.Lee.
J. Opt. Soc. Amer., Vol. 50, No. 12, 1321-2 (Dec., 1960).

Infrared studies of hydrogen—deuterium exchange in bulk fused silica indicate that the rate of exchange steadily increases with temperature from 600 to 1000° C. The exchange takes place on isolated OH groups and occurs in either direction.

1476 ELECTRON EXCHANGE BETWEEN THALLIUM (I) AND THALLIUM (III). H.J.Born and H.Vogg.
Z. Naturforsch. (Germany), Vol. 15a, No. 8, 738 (Aug., 1960). In German.

The experiments of Prestwood and Wahl (J. Amer. Chem. Soc., Vol. 71, 3137, 1949) on the homogeneous electron exchange of Tl(I)—Tl (III) catalysed by Pt, involved the as yet unsolved problem of a zero exchange period. It is now shown from work on the precipitation of thallium (III) hydroxide, in which there is heterogeneous exchange between solid trivalent and dissolved monovalent thallium, that the above period varies with the nature of the precipitation and this must also hold for the homogeneous exchange above. H.H.Hodgson

1477 MASS SPECTROMETRIC DETECTION OF FREE METHYL RADICALS IN METHANE SUBJECTED TO ELECTRICAL DISCHARGE. N.N.Dogramadži and K.F.Zmbov.
Bull. Inst. Nuclear Sci. "Boris Kidrich" (Yugoslavia), Vol. 9, 105-9 (March, 1959).

Methane in a fast flow system was subjected to a high-frequency discharge and analysed by a mass spectrometer adapted for free radical detection. The presence of methyl radicals was indicated by the observation that the ion-current ratio CH_3/CH_4 increased when the discharge tube was excited.

1478 MASS SPECTROMETRIC INVESTIGATIONS ON ION-MOLECULE REACTIONS AND ON THE ASSOCIATION OF WATER WITH A FIELD EMISSION ION SOURCE. H.D.Beckey.
Z. Naturforsch. (Germany), Vol. 15a, No. 9, 822-7 (Sept., 1960). In German.

A new low-temperature field emission source with electrostatic focusing is described. With the use of this improved ion optical device, the dependence of ion-molecule reactions on field strength was examined. The spectrum of methanol, for example, showed an intense peak at mass number 33; however, the ratio $(CH_3OH_2^+)/(CH_3OH^+)$ decreased sharply with the field strength. The ion source gives a peak broadening for very high fields, and this was demonstrated with N_2. Here, in the presence of water vapour, N_2H^+ ions were found, whose concentration decreased appreciably with the maximum value of 10^{-5}, and appears to be similar on both (111) and (11$\bar{1}$) surfaces. The cleaned surface pattern could be regenerated by heating the crystal at about 330°C for approximately 1 hr.

1448 SOME ASPECTS OF RESEARCH ON THIN SOLID FILMS. K.M.Greenland.

J. sci. Instrum. (GB), Vol. 38, No. 1, 1-11 (Jan., 1961).

The practical importance of the structure of thin films deposited in vacuo and of the relationship between film and substrate is illustrated by description of a number of new thin-film devices. A brief history of research on thin films leads to a survey of some recent work on the nucleation, growth and structure of films examined by electron and field emission microscopy, and on the measurement of film-substrate binding energy.

1449 A METHOD FOR THE PRODUCTION OF THIN FILMS ESPECIALLY CARBON FILMS. M.Müller.

Exper. Tech. der Phys. (Germany), Vol. 8, No. 3, 133-7 (1960). In German.

Spectrographically pure carbon was evaporated in an electrical arc in a vacuum and the carbon gas ionized in a capillary ion source. The positive carbon ions were extracted and electrostatically focussed onto a collector permitting their separation according to both mass and energy. With the apparatus described positive carbon ions of single charge with a maximum current of 14×10^{-8} A were collected on targets over an area of 0.4 cm². In a period of 70 minutes a total mass of 7.3×10^{-6} g of carbon was collected. W.Steckelmacher

1450 THE EFFECT OF ULTRASONICS ON THE STRUCTURE OF VACUUM-DEPOSITED ZINC AND BERYLLIUM FILMS. B.E.Popov.

Fiz. Metallov i Metallovedenie (USSR), Vol. 9, No. 3, 366-8 (March, 1960). In Russian.

The application of ultrasonic vibrations (15 μ amplitude, 17.2 kc/s frequency) to the substrates on which Be and Zn films were vacuum-deposited brought about a considerable refinement of the grain structure of the films and inhibited the development of preferred orientation. The grain-size of films produced under these conditions varied across their thickness, being smallest in the layer adjacent to the solid–vapour interface. M.H.Sloboda

1451 X-RAY INVESTIGATION OF STRESSES OF THE SECOND TYPE IN THIN VACUUM-DEPOSITED FILMS OF SODIUM CHLORIDE AND ALUMINIUM.

M.A.Levitskaya and E.A.Kuznetsova.

Fiz. Metallov i Metallovedenie (USSR), Vol. 9, No. 4, 507-9 (April, 1960). In Russian.

The results of harmonic analysis of the energy distribution in X-ray lines indicated that the magnitude of internal stresses of the second type, present in thin Al and NaCl films vacuum-deposited on glass, Mg, Ta, Mo and Al substrates, increases with increasing difference between the thermal expansion coefficient of the substrate material and the vacuum-deposited films. It was inferred therefrom that, in analogy to stresses of the first type, stresses of the second type are also caused by differential contraction of the substrates and vacuum-deposited layers. M.H.Sloboda

1452 MECHANICAL PROPERTIES OF THIN SINGLE-CRYSTAL GOLD FILMS. A.Catlin and W.P.Walker.

J. appl. Phys. (USA), Vol. 31, No. 12, 2135-9 (Dec., 1960).

Single-crystal gold films were grown by vacuum deposition on heated (375°C) sodium, chloride substrate blanks. Completely oriented films with thicknesses between 1000 and 3000 A were obtained, with the plane of the film being the {100} crystallographic plane. A small hole was drilled through the substrate with a water jet, and the mechanical properties were determined by stressing the unsupported film over this hole. The films were observed to undergo considerable plastic deformation, accompanied by the appearance and growth of mechanical twin bands as the stress was increased. X-ray diffraction studies were made to determine the twin orientation. Both the ultimate tensile stress and the elastic modulus were found to increase as the thickness of the films was reduced.

1453 A METASTABLE PHASE IN Sn–Mg ALLOY FILM. R.Suganuma.

J. Phys. Soc. Japan, Vol. 14, No. 5, 685-6 (May, 1959).

Electron-diffraction studies of thin films, prepared by successive evaporation of Sn and Mg on Formvar films at room temperature, revealed a new phase which disappeared when Mg-rich films were heated to about 150°C. With Sn-rich films, parts of the films contained the new phase at temperatures up to 315°C. Bulk specimens, containing 65 at.% Sn, prepared by vacuum melting of Sn and Mg did not show this phase. It is concluded therefore that the new phase is metastable to about 150°C for Mg-rich material and to about 315°C for Mg-deficient material. The space group is estimated to be P_{bnn}. A.E.Kay

1454 AN INVESTIGATION OF PROPERTIES OF THIN LITHIUM FILMS BY USE OF THE $Li^7(p,n)Be^7$ REACTION. J.E.Monahan and F.P.Mooring.

Nuclear Instrum. and Methods (Internat.), Vol. 6, No. 4, 343-53 (March, 1960).

The (p, n) reaction in thin films of lithium and lithium fluoride evaporated on tantalum backings was used to obtain a quantitative measure of possible irregularities in the thickness of such films. Evidence is presented that metallic lithium films are not only nonuniform in thickness but also that this apparent nonuniformity becomes more pronounced as these films are bombarded with protons. On the other hand, lithium fluoride films seem to be of uniform thickness but the effect of proton straggling produces an apparent nonuniformity which can be analysed to give the energy spectrum of protons emerging from the films. Consequently, this type of measurement can be used to obtain the stopping power and stragglin distribution of protons in targets which give rise to a (p, n) or (p,γ) reaction. A simple method of analysing conventional "rise-curve" measurements is suggested. It gives a more nearly accurate calibration of neutron energies and a more complete description of the neutron energy spectrum.

PRODUCTION OF THIN FILMS BY EVAPORATION. See Abstr. 184

1455 OPTICAL AND ELECTRON DIFFRACTION STUDY OF GOLD–TIN ALLOYS DEPOSITED BY SIMULTANEOUS EVAPORATION. E.Toma, I.Teodorescu and G.Hollos.

Stud. Cercetari Fiz. (Roumania), Vol. 10, No. 1, 63-73 (1959). In Roumanian.

The evaporation and the simultaneous deposition of gold and tin in vacuum produced known phases of the system Au-Sn (optical evidence is adduced to show this). In the visible region of the spectrum (4500 to 6400 A) the reflectivity was measured for the intermetallic compounds and also for the mixtures in the intermediate transition zones. The presence of the compounds was verified by the use of electron diffraction in transmission through a thin film of alloy. S.Tolansky

1456 OBSERVATION OF ADSORPTION ON AN ATOMIC SCALE. G.Ehrlich and F.G.Hudda.

J. chem. Phys., Vol. 33, No. 4, 1253-4 (Oct., 1960).

By means of the field ion microscope [see E.W.Muller. Proceedings of the 4th International Conference on Electron Microscopy, Vol. 1, p. 820. Berlin: Springer–Verlag (1960)] it has been possible to observe how nitrogen atoms are adsorbed on to a tungsten surface. Nitrogen atoms formed by surface dissociation of the N_2 molecules are not uniformly adsorbed when the surface is at 300°K but are found only on high index lattice planes. This nonuniformity of adsorption arises from differences in the dissociation rates. It is concluded that at 300°K rapid dissociation of N_2 molecules requires not only lattice steps, but kinked steps at which the nitrogen molecules make the largest number of nearest neighbour contacts with exposed surface atoms. J.Iball

1457 GAS ADSORPTION AND SURFACE CHARGE DENSITY OF GERMANIUM SURFACES. M.J.Sparnaaij.

J. Phys. Chem. Solids (GB), Vol. 14, 111-16 (July, 1960).

The influence upon adsorption properties is studied of the presence of discrete charge units at the surface of an adsorbent assuming a model given by Esin and Shikov, and by Grahame. This influence is certainly small when the surface charge density is lower than 10^{13} e/cm² and it is also small when this density is higher than 10^{15} e/cm². The influence may be appreciable when the surface charge density is in between these two values. A possible application may be found in the interpretation of adsorption data of argon at an oxidized germanium surface, such a surface then would carry 10^{14}-10^{15} e/cm² which are compensated by positive charges at a distance of some angstrom units in the direction of the bulk. Data concerning the chemisorption of oxygen at a non-oxidized germanium surface are also given.

d strength. With water, only traces of H_2O^+ ions were found, ause the reaction $H_2O^+ + H_2O \rightarrow H_3O^+ + OH$ is almost quantitative ng to the erosion of the pointed tungsten electrode in the presence vater and the consequent reduction in field strength even for nparatively high applied voltages. By adding a large excess of tone to a small partial pressure of water, comparable concen- tions of H_2O^+ and H_3O^+ ions were obtained. At −195°C. polymers to $H^+ \cdot (H_2O)_{10}$ were found. In very strong fields the water dipoles orientated parallel and cannot rotate. From a calculation of the reased rate of dissociation at a field strength of 1.5×10^7 V/cm, ielectric constant of 28.8 was obtained. This would correspond much hindered, though not completely suppressed rotation of dipoles. R.Schnurmann

1479 THE CHEMISORPTION OF NITROGEN ON POLY- CRYSTALLINE TUNGSTEN RIBBON: KINETIC AND NTACT POTENTIAL STUDIES. P.L.Jones and B.A.Pethica.
c. Roy. Soc. A (GB), Vol. 256, 454-69 (July 19, 1960).

The kinetics of chemisorption of nitrogen on a polycrystalline gsten ribbon were studied under ultra-high vacuum conditions flow method using a flash-filament technique similar to that cribed by Becker and Hartman (1953). The change of contact ential of the tungsten ribbon during the chemisorption reaction simultaneously measured by continuous monitoring of the racteristics of a space-charge limited diode with the ribbon used node. Both the "sticking probability" and the apparent dipole nent of the adsorbed layer change markedly at a coverage of $\times 10^{14}$ atoms/cm² at room temperature. At higher temperatures changes in both sticking probabilities and apparent dipole nents occur at lower coverages. The requirements of a simple -site adsorption model to explain these results are discussed, are compared with kinetic theories recently given by Ehrlich 55, 1956), Kisliuk (1957, 1958) and Gundry and Tompkins (1956).

1480 THE CHEMISORPTION OF HYDROGEN ON NICKEL. E.Rideal and F.Sweett.
c. Roy. Soc. A (GB), Vol. 257, 291-301 (Sept. 20, 1960).

The pressure of hydrogen in equilibrium with hydrogen absorbed nickel films produced by evaporation was measured by means of onization gauge. Observations were made at temperatures up to °C and included a previously unexplored range of surface erages, θ, down to about $\theta = 0.005$. From the results the molar differential entropies of the adsorbed hydrogen at 25°C and the gral and isosteric heats of adsorption were calculated. The molar ropy in the range $\theta = 0$ to 0.4, agreed satisfactorily with the view the adsorbed hydrogen was localized on sites which were ener- cally homogeneous. However, the entropy and the heat of adsorp- indicated that there were sites of higher adsorption potential ch amounted to about 1.5% of the surface. As θ increased from to 1.0 the observed molar entropy at 25°C indicated a progressive rease in the proportion of the adsorbed hydrogen which, at any nent, was migrating over the surface. This proportion, and the vation energy for migration, were calculated by comparison with entropies of ideal systems. Near complete coverage the adsorbed rogen exhibited the behaviour of a two-dimensional gas. Indeed, the range $\theta = 0.5$ to 1.0 the strength of the hydrogen–metal bond but little influenced by the instantaneous position of the hydrogen n relative to the surface nickel atoms. In the range $\theta = 0$ to 0.77 as found that at a fixed fractional coverage the heat of adsorption independent of temperature.

481 THE LOW-TEMPERATURE INTERACTION OF OXYGEN WITH EVAPORATED GERMANIUM FILMS.
.Bennett and F.C.Tompkins,
c. Roy. Soc. A (GB), Vol. 259, 28-44 (Nov. 22, 1960).

The interaction of oxygen with evaporated germanium films of purity was examined in the temperature range 78 to 493°K. ll temperatures, there was an initial fast process (arbitrarily ned as the uptake of oxygen within 1 min of introduction of the followed by a slow uptake, the rate of which depended on the are-root of the oxygen pressure and followed exactly an Elovich ation. Sorption was irreversible except that there was a small erage (~0.1%) of less strongly held, probably molecularly sorbed, gen. The coverage during the fast process ranged between and 78°K and 1.0 atoms/site at 273°K, while the total uptake at and 493°K was equivalent to two and three atom layers respec- ly. At the lower temperatures (78 and 90°K) there was in addition versible molecular physical adsorption having an isosteric heat kcal/mole. Direct evidence of incorporation of oxygen into the nanium was also obtained and some activation energies for the process were measured. Both the initial rapid chemisorption and the slower incorporation process effected considerable loss of area and extensive measurements of both the thermal and oxidative sintering were made. This major loss in area on oxidation is a consequence of the mechanism of oxidation, although in part it may arise from the exothermic nature of the sorption processes. The kinetics of the oxygen uptake were interpreted in terms of a place-exchange mechanism at the termination of dislocations at the surface. The first layer comprises oxygen adatoms predominantly covalently bonded to the germanium surface atoms and higher layer adsorption is due to the attachment of oxygen molecular ions at specific localities. These conclusions are consistent with, and may account for, the main surface electrical phenomena such as the changes of work function, surface conductance, field effects, etc., brought about by interaction of oxygen with a clean germanium surface.

1482 THE INTERACTION OF KRYPTON, OXYGEN AND HYDROGEN WITH IRON FILMS. M.W.Roberts.
Trans Faraday Soc. (GB), Vol. 56, Pt 1, 128-37 (Jan., 1960).

Krypton has been shown to form a monolayer on iron films at 78°K at pressures of around 10^{-2} mm. The isotherms obey the Brunaner–Emmett–Teller equation although outside the generally accepted valid range of relative pressure. The adsorption of krypton has been studied as a function of the pre-treatment of the iron surface. Variations in the krypton monolayer have been followed during the annealing, at 23°C and a pressure $< 10^{-6}$ mm, of films prepared by deposition at −195°C. The activation energy of the initial sintering process is around 4 kcal mole^{-1} and a mechanism based on vacancy cluster diffusion is suggested. The effect of adsorbed oxygen and hydrogen on the physical adsorption of krypton has been investigated and is discussed. The Halsey–Singleton equation is applied to the krypton isotherms in the pre-monolayer region. Drastic changes in the values of the interaction energy and compatability factor occurs as the coverage approaches a monolayer. Such changes are considered to reflect differences in the mechanism of krypton adsorption at low and high surface coverages.

ELECTROCHEMISTRY

1483 STUDY OF THE ELECTRONIC EXCHANGE AT THE SEMICONDUCTOR—NON-AQUEOUS ELECTROLYTE INTERFACE. M. Balkanski, J.Bardeleben and A.F.Bogenschutz.
J. Chim. phys. (France), Vol. 57, No. 6, 507-17 (June, 1960). In French.

A theoretical treatment based on knowledge of the intrinsic semiconductor properties and the Fermi level allowed the prediction of the semiconductor type at the face of non-aqueous redox solutions. The variations of the overvoltages with current densities for the redox systems Ti^{3+}/Ti^{4+} and I_3^-/I^- were in good agreement with the theoretical predictions. Light shone on the electrode caused an instantaneous change in the potential which was explained in terms of carrier generation. The magnitude of this effect changed monotonically with temperature and could be associated with trapping and recombination at surface states. I.Cooke

1484 THE CHARGE DISTRIBUTION AT THE ZINC OXIDE— ELECTROLYTE INTERFACE. J.F.Dewald.
J. Phys. Chem. Solids (GB), Vol. 14, 155-61 (July, 1960).

Capacitance measurements made on single crystal zinc oxide electrodes in contact with aqueous electrolytes are reported. Over a wide range of bias and bulk donor density, the results are in almost quantitative accord with predictions of the simple Poisson—Bolzmann (Poisson—Fermi in the degenerate case) equation. This is shown to imply the complete absence of surface-state effects in this system. A very sharp discontinuity in the flat-band potential is observed at bulk electron densities in the range from 0.6×10^{18} to 2×10^{18} donors/cm². This and other effects, arising under varying surface treatments, are discussed in some detail.

1485 POTENTIAL—TIME CURVES OBTAINED DURING THE STRESS CRACKING OF METALS.
L.R.Scharfstein and C.M.Eisenbrown.
Nature (GB), Vol. 188, 572-3 (Nov. 12, 1960).

The electrochemistry of two 12% chromium martensitic steels was studied while they were cracking in a 1% hydrochloric acid solution containing 1% selenium dioxide. It was concluded that the cracking was due to hydrogen embrittlement. The form of the potential—time curves is compared with those for austenitic stainless steels undergoing stress corrosion cracking in magnesium chloride solution. A tentative explanation is advanced for the observed potential changes, which in the former case, are influenced by the presence of the selenium dioxide. A.E.Kay

1486 DIRECT MEASUREMENTS OF PROTON MOBILITIES IN PROTONATED ICE. F.Heinmets.
Nature (GB), Vol. 188, 925-7 (Dec. 10, 1960).

The velocity of protons in ice obtained by freezing supercooled 0.1 M HCl solutions is determined by the moving boundary method. Results are three orders of magnitude smaller than the proton velocity estimated in ice from pure water. G.I.W.Llewelyn

1487 CORRELATION OF STANDARD ELECTRODE POTENTIAL WITH ATOMIC AND IONIC RADII OF METALS. K.S.Rajagopalan and P.B.Mathur.
Naturwissenschaften (Germany), Vol. 47, No. 16, 374-5 (1960).

A correlation is pointed out, and discussed, between the difference $R_a - R_i$ (R_a = atomic radius; R_i = ionic radius of a metal atom) and the standard electrode potential of that metal. L.Pincherle

THE SURFACE RECOMBINATION ON SILICON CONTACTING AN ELECTROLYTE. See Abstr. 1068

PHOTOCHEMISTRY
RADIATION CHEMISTRY

1488 DECOMPOSITION OF WATER BY LIGHT. H.Kallmann and M.Pope.
Nature (GB), Vol. 188, 935-6 (Dec. 10, 1960).

Illumination of one side of an anthracene crystal placed between and separating two 1M solutions of sodium chloride produced an electric current in an external wire joining the two solutions. This arises from the development of a pure photovoltage and/or from the electrochemical potential which would exist if there were differences in either the two solutions or the two sides of the crystal. W.Good

1489 THE KINETICS OF RADICAL REACTIONS IN γ-IRRADIATED POLYVINYL CHLORIDE.
K.Hukuda, J.Ishii and Z.Miduno.
J. Phys. Soc. Japan, Vol. 14, No. 11, 1643-4 (Nov., 1959).

The rates of production of radicals in polyvinyl chloride irradiated with Co^{60} γ-rays were measured by electron spin resonance at a wavelength of 3 cm. The results cannot be explained by any n-th order reaction equations, but can be explained on the basis of the production of two groups of radicals, which do not interact, one of which has a first-order and the other a second-order reaction mechanism. The activation energies of the two groups are estimated at 18 kcal/mol and 4 kcal/mol respectively. C.B.Allsopp

1490 KINETICS OF RADIATION-INDUCED CHEMICAL REACTIONS. J.P.Keene.
Nature (GB), Vol. 188, 843-4 (Dec. 3, 1960).

The irradiation apparatus used is described and the results obtained on aqueous solutions of ferrous ammonium sulphate and ceric sulphate presented and discussed. The rate of oxidation and reduction, respectively, of these compounds under irradiation is followed by measurement of change of optical absorption. G.I.W.Llewelyn

1491 DISSOCIATION OF UF_6 BY URANIUM FISSION FRAGMENTS. V.A.Dmitrievskii and A.I.Migachev.
Atomnaya Energiya (USSR), Vol. 6, 533 (1959). In Russian. English translation in: Reactor Science (GB), Vol. 12, No. 4, 185-90 (Aug., 1960).

It is shown that on exposure to neutrons, UF_6 decomposes (apparently into UF_5 and fluorine). The G value is about 0.5 mole/100 eV, or 0.21 mole $hr^{-1}kW^{-1}$ expended in the gas. It is shown also that recombination of the decomposition products of UF_6 takes place under irradiation; equilibrium concentrations of fluorine and UF_6 are set up which depend on the dose-rate. When mixed with fluorine, UF_6 is stable to radiation even at room temperature, and could be used as a heat-exchange material for reactors.

DISPERSIONS . COLLOIDS

1492 HETEROGENEOUS NUCLEATION BY AGGREGATES OF PARTICLES. R.B.Head and K.L.Sutherland.
Austral. J. Phys., Vol. 13, No. 3, 584-98 (Sept., 1960).

The induction of a new phase by fine particles of a nucleating substance is complicated not only by variation in sizes but also by aggregation. The general effect of aggregation is to decrease the total number of particles and to reduce the supercooling (or supersaturation) necessary for growth of a new phase. Point contacts appear to be more fruitful than do line contacts, although both may be able to cause a substance to be more active than a large flat su face of the substrate. If the contact between particles is not a spec ally favoured position for nucleation, an aerosol as a whole appear to contain a higher proportion of active particles because of the pe sistence of initially active particles and the loss of less active one

1493 PARTICLE SIZE DISTRIBUTIONS IN ULTRASONIC EMULSIFICATION. E.S.Rajagopal.
Proc. Indian Acad. Sci. A, Vol. 49, No. 6, 333-9 (June, 1959).

The sizes were studied and were shown to be of the same orde (~ 1μ) as those obtained in colloid mills. The effect of continued irradiation to increase the mean size of the particles and to broade the size distribution. The results are quantitatively analysed in terms of the lognormal particle size distribution.

PHYSICAL METHODS OF CHEMICAL ANALYSIS

1494 MONITOR FOR THE QUANTITATIVE DETERMINATIO OF BERYLLIUM IN THE ATMOSPHERE.
M.S.W.Webb, R.J.Webb and P.C.Wildy.
J sci. Instrum. (GB), Vol. 37, No. 12, 466-71 (Dec., 1960).

The air is drawn through a triggered intermittent arc and the intensity of the beryllium doublet at 3130 A is monitored, together with the adjacent background, and the ratio of these intensities is recorded on a ratio recorder. Provision is made for frequent calibration by means of an aerosol of known concentration, produc by an auxiliary spark between beryllium–copper electrodes. The accuracy and sensitivity of the instrument are not materially affected by the chemical form of the beryllium, and are unaffected by the sizes of particles normally encountered in atmospheric dus The instrument is mobile, fully automatic and rapid in operation, one result being produced each minute. The limit of detection is 1 $\mu g/m^3$ for a twenty-second sampling time. The instrument is considered to have potentialities for the determination of other elements in air, apart from beryllium.

1495 XENON–KRYPTON SEPARATION BY GAS CHROMATOGRAPHY. R.C.Koch and G.L.Grandy.
Nucleonics (USA), Vol. 18, No. 7, 76, 78, 80 (July, 1960).

Kr^{85} and Xe^{133} were used as tracers to determine a practica separation procedure using charcoal columns. Absorption at –11 and elution with helium at 32° and 70° F at flow rates of 0.6 and 1.6 l./min at 15 lb/in^2 abs. were studied. Good separation was achieved and the results were compared with calculations based o a plate theory of chromatography. R.D.Sm

GEOPHYSICS

1496 THE INTERNATIONAL GEOPHYSICAL YEAR. R.Stoneley.
ture (GB), Vol. 188, 529-32 (Nov. 12, 1960).

A report of a symposium arranged by Section A (Mathematics
l Physics) of the British Association and held at Cardiff on
ept., 1960.

1497 SOME OBSERVATIONS AT HALLEY BAY [ANTARCTICA] IN SEISMOLOGY, GLACIOLOGY AND METEOROLOGY.
lacDowall.
oc. Roy. Soc. A (GB), Vol. 256, 149-92, 192-7 (June 21, 1960).

"Halley Bay Expedition" (see Abstr. 18476 of 1960). Includes
ormation on the total and diffuse solar radiation and the atmo-
eric ozone.

1498 AN ABSOLUTE DETERMINATION OF g, AT THE PAVILLON DE BRETEUIL, BY THE METHOD OF THE
LL OF A GRADUATED SCALE. Å.Thulin.
n. Geophys. (France), Vol. 16, No. 1, 105-27 (1960). In French.

Absolute gravity measurements using high-speed cinemato-
phy of a graduated scale that falls freely in a chamber evacuated
5 × 10^{-8} mm Hg gave a result of 980 928.0 ± 1 mgals for the gra-
y station Sèvres A situated in the Laboratory building of the
reau International des Poids et Mesures at Sèvres (S.-et-O.),
ance. The Potsdam value generally admitted for the same point
980 940.8 mgals. The new result is in fair accordance with other
ent reversible pendulum determinations and confirms once more
necessity for revising the Potsdam values.

499 INVESTIGATIONS ON THE GRAVITY FIELD AND SHAPE OF THE EARTH. U.A.Uotila.
n. Acad. Sci. Fennicae A III (Finland), No. 55, 92 pp. (1960).

The paper opens with some basic considerations concerning
gravity field of the earth. A table of recent absolute deter-
nations and another one of the gravity values of national refer-
e stations determined by the author in 1956 are given. Because
number of gravity stations is increasing rapidly, the author
gests that the data should be recorded on an I.B.M. card to
ilitate exchange. Following this, the correlation $\Delta g_f = a + b \cdot h$
ween free air anomalies (Δg_f) and station elevations (h) is ex-
ined for 131 $1^{\circ} \times 1^{\circ}$ squares from various parts of the world.
e average b-value, 0.118 mgal/m, is close to the Bouguer re-
tion constant. The author's method used in determining mean
for 6679 $1^{\circ} \times 1^{\circ}$ squares in the World-Wide Gravity Project is
en. The formula of Hirvonen (1956) for the mean anomaly of a
are is examined and it is concluded that his mathematical pro-
ure cannot be used alone. The author suggests alternatively
t "the observed anomaly should be first reduced to correspond
he mean elevation of the square and then the mean anomaly of
squares should be computed". The next 20 pages are devoted
he computations of the undulations of the geoid. A numerical
nique is described briefly and then the author's method for
h-speed computation is given in detail. This method was used
omputing the "Columbus geoid" and in detailed investigations
he geoid undulations in many "regional areas" of the world.
25 pages following this are devoted to deflections of the
tical. Basic formulae are derived and a manual method using
plates is discussed in great detail. The section concludes by
cribing the author's high-speed computation technique. It is
owed by a brief but clear discussion of the estimation of ano-
ies in unsurveyed areas to obtain a knowledge of the errors
sed by lack of gravity information, in undulation and deflection
nputations. The last section presents a high-speed integration
hod for the determination of the shape of geopotential surfaces
igh elevations. Examples of such computations along a parallel
und the world are given. D.S.Parasnis

1500 AN IMPROVED BRONZE PENDULUM APPARATUS FOR RELATIVE GRAVITY DETERMINATIONS.
.D.Thompson.
l. Dominion Oos. Ottawa (Canada), Vol. 21, No. 3, 145-76 (1959).

A bi-pendulum apparatus which uses bronze half-second
dulums is described. Variable factors such as temperature,
ssure, arc, time, etc., are precisely controlled so that all observations are made under identical conditions and no corrections need be applied to the observed periods. Results show that repeated swings with one pair of pendulums give observed periods (the mean of two pendulums) which are consistent to about ±8 × 10^{-8} sec. For repeated occupations of the same site the mean period for 3 or more swings with one pair of pendulums is consistent to about 5 × 10^{-8} sec (±0.2 milligal). Observations with several pairs of pendulums give gravity differences that are accurate to the order to ±0.2 milligal. Gravity values obtained with this apparatus in 1957 are in close agreement with other pendulum and gravimeter values. The difference in gravity between the national reference piers in Ottawa, Canada and Washington, D.C. has been evaluated at 501.50 milligals with a standard deviation of 0.08 milligal. Relative to the adopted value of 980.62200 cm/sec² for the Ottawa reference pier, the following gravity values have been obtained for important sites in the United States and Canada:

Washington (Commerce pier): $g = 980.12050$ cm/sec^2
Vancouver (U.B.C. Physics Bldg.): $g = 980.93676$ cm/sec^2
Winnipeg (Dominion Public Bldg.): $g = 980.99483$ cm/sec^2

1501 ELASTICITY OF ROCKS AND SOME RELATED GEOPHYSICAL PROBLEMS. D.Shimozuru.
Japan J. Geophys., Vol. 2, No. 3, 1-85 (March, 1960).

1502 THE PHYSICAL CONSTANTS OF SEA ICE. D.L.Anderson.
Research (GB), Vol. 13, No. 8, 310-18 (Aug., 1960).

All the physical properties are extremely temperature dependent and are controlled by the quantity of brine in the interstices. The basic physical and thermal properties of sea ice are presented in tables and graphs; the apparently erratic behaviour is caused by precipitation of cryohydrates.

ATMOSPHERE

(Troposphere and Stratosphere)

SOME OBSERVATIONS AT HALLEY BAY [ANTARCTICA] IN SEISMOLOGY, GLACIOLOGY AND METEOROLOGY. See Abstr. 1497

1503 THE OXFORD—KEW OZONE SONDE. A.W.Brewer and J.R.Milford.
Proc. Roy. Soc. A (GB), Vol. 256, 470-95 (July 19, 1960).

An ozone sonde capable of measuring and transmitting the local ozone concentration was developed for the I.G.Y. and is described in some detail. A continuous electrochemical detector measures the ozone concentration, providing a d.c. electric current of 0 to 5 μA according to the amount of ozone in the air passed through it. This output current is telemetered by current-controlled variable inductance which is interchangeable with a standard inductance coil in a Kew radiosonde. The element is of low cost, weighs about 600 g and requires very limited auxiliary equipment for its use. Sixty-five successful ascents have been made and the results of the European ascents are given.

1504 VERTICAL DISTRIBUTION OF ATMOSPHERIC OZONE. COMPARISON OF VARIOUS METHODS.
A. INTRODUCTION. M.Migeotte. In French.
B. ELECTRO-CHEMICAL OZONE SONDE. A.W.Brewer and J.R.Milford.
C. VERTICAL OZONE DISTRIBUTION FROM THE UMKEHR EFFECT. H.U.Dütsch.
D. OPTICAL OZONE SONDE. H.K.Paetzold and F.Piscalar. In German.
E. INFRARED METHOD. E.Vigroux. In French.
Ann. Geophys. (France), Vol. 16, No. 2, 196-7, 197-9, 200-7, 207-11, 211-22 (1960).

Vertical distributions of atmospheric ozone have been determined by using, simultaneously and at the same place, four different methods. A comparison of the results thus obtained is made.

1505 VERTICAL DISTRIBUTION OF ATMOSPHERIC OZONE AT DIFFERENT LATITUDES. A.Vassy and I.Rasool.

Ann. Geophys. (France), Vol. 16, No. 2, 262-3 (1960). In French.

1506 INVESTIGATION OF ATMOSPHERIC OZONE BY PHOTOMETRY OF LUNAR ECLIPSES. V.G.Fesenkov.

Astron. Zh. (USSR), Vol. 36, No. 4, 564-72 (1959). In Russian. English translation in: Soviet Astron.—AJ (USA), Vol. 3, No. 4, 554-62 (Jan.-Feb., 1960).

The illuminations at different phases of an eclipse are calculated for a standard atmosphere without ozone and also for an ozone admixture with different distributions with height above sea level. The results are summarized in a table, in which are given: (1) the different limiting heights in the atmosphere still illuminated by solar rays, as it appears from the moon; (2) the corresponding phase angles for the area of the moon being observed, i.e., the angular distance of the area from the centre of the earth's shadow; (3) the illumination I/I_0 for $\lambda = 0.5\ \mu$, calculated for a standard atmosphere without ozone in units of illumination produced by an uneclipsed sun; (4) and (5) the same as (3) but for an ozone admixture with a total vertical thickness equal to 0.031 and a maximum concentration at heights of 21 and 26 km, respectively; (6) and (7) the absorption due to ozone under these conditions, expressed in stellar magnitudes. From an analysis of photometric curves, it is possible to determine the distribution of ozone with height and also the total amount of ozone in the atmosphere.

1507 THE ACCURACY OF DETERMINATION OF THE VERTICAL DISTRIBUTION OF ATMOSPHERIC OZONE FROM EMISSION SPECTROPHOTOMETRY IN THE 1043 cm^{-1} BAND AT HIGH RESOLUTION. C.D.Walshaw.

Quart. J. Roy. Meteorol. Soc. (GB), Vol. 86, 519-29 (Oct., 1960).

A method is outlined for obtaining the vertical distribution of atmospheric ozone from ground-level measurements of the downcoming thermal radiation in the region of the 1043 cm^{-1} (9.6 μ) band The emission measurements are such as may be made with a grating spectrometer of the Goody type; the slit width is about 2.5 cm^{-1}, enabling interference from water vapour and carbon dioxide lines to be eliminated. Estimates are made of the various sources of error, using a model atmosphere having three ozone variables (which are the ozone contents of the layers 1000-600, 600-300 and 300-50 mb), and basing the analysis on four combinations of wave number and zenith angle of observation. It is concluded that results of useful accuracy may be obtained for the two tropospheric layers, but that the method is not sufficiently sensitive to give significant information on the upper layer. The continuous absorption over the region lowers the accuracy appreciably but does not affect the main conclusion.

1508 A NEW METHOD FOR DETERMINING AIR HUMIDITY BY THE HEAT EXCHANGE OF A COOLED THERMISTOR. A.Malinovski and D.Yordanov.

C. R. Acad. Bulg. Sci., Vol. 12, No. 6, 521-4 (Nov.-Dec., 1959).

A miniature thermistor, used as a thermometer, is cooled to below the dew point for a short time by applying a small drop of a cooling mixture. The temperature of the thermometer will rise more rapidly from sub-dew point temperatures to the dew point due to the heat added by condensing water vapour than it will fall from temperatures above the dew point due to heat loss by evaporation of the film of water or ice. The dew point found will correspond to the temperature at which a dynamical equilibrium is established between the vapour pressure in the air and the saturation pressure at the water (ice) surface, and it will not depend upon the character or condition of the underlying surface. The theory and experimental method are explained. The method can be used for distant observations and practically no inertia occurs. R.S.Read

1509 ON TURBULENT HEAT EXCHANGE IN THE AIR NEAR THE GROUND.

W.R.Van Wijk, W.J.Derksen and H.Goedkoop, Hzn.

Physica (Netherlands), Vol. 25, No. 12, 1259-70 (Dec., 1959).

A method for measuring the turbulent exchange coefficient, k, in air is described. The method uses the propagation of a heat impulse. Such impulses occur when a period of cloudiness is interrupted by bright sunshine. The rise in temperature at 200 cm was calculated from that at 3 or at 10 cm height assuming a linear linear variation of k with height. From the comparison of the calculated curves with the recorded temperature, k at 200 cm was determined. A value considerably lower than obtained in other investigations was found. A discussion of the possible causes of this discrepancy is deferred until further data are available. The calculations are considerably shortened if k is determined from a comparison of the Laplace transforms of the recorded temperatures at two heights.

1510 NEAR INFRARED ATMOSPHERIC TRANSMISSION TO SOLAR RADIATION. D.M.Gates.

J. Opt. Soc. Amer., Vol. 50, No. 12, 1299-1304 (Dec., 1960).

Near infrared solar spectrum observations taken on October 1 1954, with a double-pass NaCl prism spectrometer have been analysed for transmission coefficients,for the "selective" absorpti factor and for the "continuum" factor. The analysis was carried out for 59 wavelength positions between 0.872 and 2.537 μ. The monochromatic data fit well the law $^0nT = c_1(w)^{1/2}$ where w is the amount of water vapour in the optical path. The coefficient c_1 is given as a continuous function of the wavelength. A coefficient of extinction for the "continuum" factor is also given.

ICE-FORMING NUCLEI. See Abstr. 1372

1511 SPECTRAL RADIANCE OF SKY AND TERRAIN AT WAVELENGTHS BETWEEN 1 AND 20 MICRONS.

I. INSTRUMENTATION.

R.A.Oetjen, E.E.Bell, J.Young and L.Eisner.

J. Opt. Soc. Amer., Vol. 50, No. 12, 1308-13 (Dec., 1960).

A description is given of a mobile laboratory equipped with two spectrographs for radiance measurements of the sky and terra between 1 and 20 μ. The laboratory has its own a.c. power supply and means for controlling its temperature. Procedures are described for calibrating the instrumentation and transforming the dat into spectral radiance (in microwatts cm^{-2} steradian^{-1} micron^{-1}) a a function of wavelength.

1512 SPECTRAL RADIANCE OF SKY AND TERRAIN AT WAVELENGTHS BETWEEN 1 AND 20 MICRONS.

II. SKY MEASUREMENTS.

E.E.Bell, L.Eisner, J.Young and R.A.Oetjen.

J. Opt. Soc. Amer., Vol. 50, No. 12, 1313-20 (Dec., 1960).

Quantitative data are presented to illustrate the infrared spectral radiance of the sky under a variety of situations. A quali tative discussion of the dominant spectral features is given to sho the importance of the emission and scattering processes, the effe of angle of elevation, angle of azimuth, sun angle, and cloud cover

1513 THE OPTICS OF MIRAGES. C.V.Raman and S.Pancharatnam.

Proc. Indian Acad. Sci. A, Vol. 49, No. 5, 251-61 (May, 1959).

Mirages were produced using a vertical heated plate to give a stratification of refractive index of the adjacent air; double and triple images were produced by light passing near the plate and th was a region very near the plate into which the light did not penetrate. The appearances are explained by assuming a linear gradient of refractive index near the plate; solutions of the wave equation with this condition agree qualitatively with the effects. W.T.Welfo

1514 DIURNAL VARIATION IN ATMOSPHERIC ELECTRICITY. T.Ogawa.

J. Geomagn. Geoelect. (Japan), Vol. 12, No. 1, 1-12 (1960).

In order to eliminate short-period fluctuations due to local effects, daily courses of potential gradient, conductivity and air-earth current were smoothed out by taking hourly overlapping mea of 5 hours and the interrelationship between each element was exa mined on every day. In urban districts, the production of man-ma nuclei begins following human activity in the early morning before sunrise and they accumulate in the lowest stable layer of the exchange layer. In the daytime, when the wind rises, the nuclei are transported into the upper layers in the exchange layer by vertica turbulent mixing due to forced convection, and there diffused hor zontally. The eliminated short-period fluctuations are on average 27% of the concerned elements. Examining diurnal variations of the fluctuations, there is no evidence that they are caused by loca generators other than the thunderstorm generator, nor that they are directly connected to strength of turbulence of the air.

1515 ELECTRICITY IN RAIN. T.Ogawa.

J. Geomagn. Geoelect. (Japan), Vol. 12, No. 1, 21-31 (1960).

Continuous observations of the rain current (i), the rate of rainfall (R') and the potential gradient (P) were made. Applying Wilson's theory of ion capture by water drops, the quantitative representation between them is obtained using the size-distributi aindrops by Marshall and Palmer (1948)

$$i = 2.12 \times 10^{-6} P_h R'^{0.84} - 0.54 \times 10^{-6} P_h R'^{1.05},$$

re i gives the maximum rain current and P_h is the potential
dient in the charging region of raindrops below the clouds.
lying the calculated result to the measured ones, it is found that
relates to P by $|P_h| = 3P^{1.3}$. The relation between the above
ılts and the Simpson's empirical ones is discussed. Further,
e results in regard to the splashing effect of raindrops at the
und and to the mirror-image effect between the rain current and
potential gradient are described.

.516 RADAR OBSERVATION OF LIGHTNING.
M.G.H.Ligda.
mos. terrest. Phys. (GB), Vol. 15, No. 3-4, 248-50 (Oct., 1959).
Radar echoes on PPI screens, believed to be due to lightning
kes about 70 miles distant, were subdivided into cloud and earth
harges. They were recorded on wavelengths from 10 to 50 cm
hey could not be detected in areas of heavy precipitation. A
ble method is described by which these radar echoes can be
d in successive frames of a film. R.H.Golde

.517 OBSERVATION OF A UNIQUE V.L.F. EMISSION.
J.H.Pope and W.H.Campbell.
eophys. Res. (USA), Vol. 65, No. 8, 2543-4 (Aug., 1960).
Describes an unusual natural electromagnetic disturbance in
v.l.f. range which has a remarkably systematic variation in its
acteristics. A.Boksenberg

518 RADIO SCATTERING BY TROPOSPHERIC
IRREGULARITIES. A.D.Wheelon.
mos. terrest. Phys. (GB), Vol. 15, No. 3-4, 185-204 (Oct., 1959).
A survey of theoretical work and comparison with experiment.
shown how irregularities in refractive index can be charac-
ed by means of space correlation functions or by the spectrum
regularity sizes. The latter can be linked to physical theories
rbulence. The theory of the scattering of electromagnetic waves
ese irregularities is considered, with reference to line-of-sight
agation and beyond-horizon propagation. Expressions derived
this theory are quoted for phase and amplitude variations of
s propagated under different conditons, and these are compared
experiment. D.M.Schlapp

.519 RECENT EXPERIMENTAL EVIDENCE FAVOURING
THE $\rho K_1(\rho)$ CORRELATION FUNCTION FOR
CRIBING THE TURBULENCE OF REFRACTIVITY IN THE
POSPHERE AND STRATOSPHERE. K.A.Norton.
mos. terrest. Phys. (GB), Vol. 15, No. 3-4,206-27 (Oct., 1959).
It is shown that the variations of refractive index of the atmos-
e in space at a fixed time can be described to a good approxi-
on by the $\rho K_1(\rho)$ correlation function. Three types of experi-
cal evidence are cited to support this. Firstly, the variations
fractive index with time at a fixed point were measured directly
a refractometer. Secondly, the variations with time of the
e of radio waves travelling over a line-of-sight path were
sured. Lastly, the received power scattered in the forward
ction to a point beyond the horizon of the transmitter was
sured. In a note added in proof, new evidence is mentioned
h suggests that the variations of refractive index with time at a
point cannot be described adequately by the assumption that
patial pattern of irregularities moves essentially unchanged.
ad, self-motion of the irregularities appears to be more im-
nt. D.M.Schlapp

1520 ATMOSPHERIC TRANSPORT OF ARTIFICIAL RADIO-
ACTIVITY. E.A.Martell and P.J.Drevinsky.
nce (USA), Vol. 132, 1523-31 (Nov. 25, 1960).

1521 RADIOACTIVITY OF ATOMIC ORIGIN IN THE AIR AND
IN PRECIPITATIONS. H.Garrigue.
Acad. Sci. (France), Vol. 251, No. 16, 1645-6 (Oct. 17, 1960).
rench.
It is found that the artificial radioactivity of the air and in
icular of the precipitations is far from being negligible.
S.J.St-Lorant

ATTACHMENT OF THORIUM DECAY PRODUCTS TO
ROSOL PARTICLES. See Abstr. 628

1522 SOUND PROPAGATION IN THE ATMOSPHERE.
W.E.Scholes.
Nature (GB), Vol. 188, 992-4 (Dec. 17, 1960).

Report of a symposium held by the Acoustics Group of the Physical Society on 8 Sept., 1960.

UPPER ATMOSPHERE IONOSPHERE

(See also Space Research. Abstracts on radiowave propagation in ionized media will also be found under Electromagnetic Waves)

1523 PROGRESS IN AERONOMY.
T.R.Kaiser.
Nature (GB), Vol. 188, 712-13 (Nov. 26, 1960).

A report of a symposium held at Copenhagen on 19-22 July, 1960 under the auspices of the International Association of Geomagnetism and Aeronomy. Papers presented covered a wide range of subjects including: atmospheric densities (up to 700 km), solar ionizing radiation, collision processes in the upper atmosphere, airglow, aurora, spectra, solar and terrestial disturbances, and the influx of interplanetary dust.

INSTRUMENTS FOR SPACE RESEARCH. See Abstr. 49

1524 GEOMAGNETIC, AURORAL, IONOSPHERIC AND COSMIC RAY PERTURBATIONS: THEIR INTERDEPENDENCE AND RELATION TO SOLAR ACTIVITY.
F.Mariani and F.Molina.
Ann. Geofis. (Italy), Vol. 13, No. 1, 85-126 (1960). In Italian.

This paper, the third of a series on the subject, deals with ionospheric perturbations. An account is given of the present state of knowledge of the storm time and diurnal disturbance variations of the critical frequency and height of the F_2 layer and their seasonal and latitude dependence, together with a short description of the behaviour of the E_1 and E layers during the perturbations. An account is also given of recent research on the polar blackouts not correlated with geomagnetic activity, which are probably due to streams of energetic protons (~ 100 MeV) from the sun. G.Martelli

1525 ATOMIC REACTIONS IN THE UPPER ATMOSPHERE.
J.Kaplan, W.J.Schade, C.A.Barth and A.F.Hildebrandt.
Canad. J. Chem., Vol. 38, No. 10, 1688-92 (Oct., 1960).

The reaction rates of nine upper atmosphere chemical reactions have been analysed with a digital computer. The dependence of the loss rates of atomic nitrogen and atomic oxygen as well as the relative concentrations of nitric oxide and nitrogen dioxide in the upper atmosphere are given. Using a flow system, nitrogen atoms were produced and then titrated by the addition of NO. The resulting nitrogen and oxygen atom densities were measured with an e.s.r. spectrometer. The dependence of the intensities of the nitrogen afterglow and the NO afterglow were related to the atom densities. An excitation mechanism for O I 5577 A has been determined from the relation of the intensity of 5577 A to the atom densities.

1526 ON THE DISTRIBUTION OF N_2^+ IONS IN THE HIGH ANTARCTIC ATMOSPHERE. G.Weill.
Ann. Geophys. (France), Vol. 16, No. 2, 223-35 (1960). In French.

Description of twilight effects in radiation 3914 A, Adelie Land. Absolute intensities as a function of sunlit regions allow N_2^+ concentrations above auroral zone to be derived. Evidence is given for a marked latitude effect.

1527 A RELATION BETWEEN IONOSPHERIC DRIFTS AND ATMOSPHERIC DYNAMO CURRENT SYSTEMS.
L.H.Heisler.
Austral. J. Phys., Vol. 13, No. 2, 188-91 (June, 1960).

Fixed frequency (5.8 Mc/s) observations in Sydney reported by Munro in 1950 and 1958 had shown that, in addition to their dominant N–S component, travelling ionospheric disturbances had a marked easterly component. In more recent years near sunspot maximum, this component has been predominantly westerly on some days. The paper relates this change to the north—south movement of the focus of the ionospheric electric current system which is responsible for the quiet day diurnal variation in the geomagnetic field. Examples of this variation as recorded at Watheroo show that the focus of the current system was north of that station in January, 1955 but south of it in January, 1957. J.M.Stagg

1528 THE DEGREE OF HOMOGENEITY OF THE QUIET IONOSPHERE. V.V.Vitkevich.

Astron. Zh. (USSR), Vol. 36, No. 4, 623-5 (1959). In Russian. English translation in: Soviet Astron.—AJ (USA), Vol. 3, No. 4, 609-11 (Jan.-Feb., 1960).

During observations of radio stars at metre wavelengths, a distinct interferometric pattern is observed in most cases when the ionosphere is not disturbed. This makes possible the estimation of the upper limit to the degree of nonuniformity of the electron plasma of the metagalaxy, Galaxy, zodiacal light, and ionosphere. The estimate for a quiet ionosphere shows that if the size of the irregularities is 3-5 km, the total number of electrons in them is only 0.3-0.4% of the total number of electrons in a column of unit cross-section.

1529 INTERNAL ATMOSPHERIC GRAVITY WAVES AT IONOSPHERIC HEIGHTS. C.O.Hines.

Canad. J. Phys., Vol. 38, No. 11, 1441-81 (Nov., 1960).

Irregularities and irregular motions in the upper atmosphere have been detected and studied by a variety of techniques during recent years, but their proper interpretation has yet to be established. It is shown here that many or most of the observational data may be interpreted on the basis of a single physical mechanism, namely, internal atmospheric gravity waves. A comprehensive picture is envisaged for the motions normally encountered, in which a spectrum of waves is generated at low levels of the atmosphere and propagated upwards. The propagational effects of amplification, reflection, intermodulation, and dissipation act to change the spectrum continuously with increasing height, and so produce different types of dominant modes at different heights. These changes, coupled with an observational selection in some cases, lead to the various characteristics revealed by the differend observing techniques. The generation of abnormal waves locally in the ionosphere appears to be possible, and it seems able to account for unusual motions sometimes observed.

1530 AN UNUSUAL IONOSPHERIC DISTURBANCE IN THE ANTARCTIC ON 30 JUNE TO 1 JULY 1957.

V.A.W.Harrison.

J. atmos. terrest. Phys. (GB), Vol. 18, No. 1, 72-5 (April, 1960).

1531 EFFECTS OF VERTICAL DIFFUSION OF ELECTRONS NEAR THE MAGNETIC EQUATOR. E.R.Schmerling.

Nature (GB), Vol. 188, 133-4 (Oct. 8, 1960).

It is considered that vertical diffusion accounts for the major features of the geomagnetic anomaly, and that this anomaly consists of excess ionization, due to diffusion, away from the equator, rather than a deficiency of ionization at the equator. This thesis is supported by some simple calculations. D.M.Schlapp

1532 OBSERVATIONS OF SUDDEN IONOSPHERIC DISTURBANCES. R.W.Morriss.

Proc. Phys. Soc. (GB), Vol. 76, Pt 1, 79-92 (July, 1960).

Observations were made of the effect of sudden ionospheric disturbances on radiowaves reflected from, and transmitted through, the ionosphere. The results of simultaneous measurements of the phase changes on waves of frequency 2-6 Mc/s were shown to indicate that they were due to an increase in the electron density which extended to above the maximum of the E-layer, and possibly up to 150 km. Simultaneous measurements of the increases in absorption of waves in the frequency range 2 to 24 Mc/s (which include measurements of cosmic radio noise) showed that there was usually an important increase in absorption in the lowest regions of the ionosphere where the electronic collision frequency was 10^7 or even 10^8 sec^{-1}. These conclusions were consistent with the observations of other workers. The above-mentioned phenomena were also compared with phase changes observed on very long waves, but since there was a large variation in the individual aspects of different sudden ionospheric disturbances, it was not possible to draw any detailed conclusions.

1533 THE IONOSPHERE OVER HALLEY BAY. W.H.Bellchambers and W.R.Piggott.

Proc. Roy. Soc. A (GB), Vol. 256, 200-17, 217-18 (June 21, 1960).

"Halley Bay Expedition" (see Abstr. 18476 of 1960). The ionospheric phenomena observed at Halley Bay, Antarctica, are briefly described, and the influence of the Weddell Sea magnetic dip anomaly stressed. Some ionization is generated in the lower ionosphere by solar photo-ionization processes at solar zenith angles up to about 100°. The F2-layer variations appear to be dominated by movements of ionization which can also be seen near the maximum of the F1-layer. Ionization drift velocities in the E-region reverse with season and are greater in winter than in summer. Other features of drift and absorption are generally consistent with those expected. The incidence of spread F is very anomalous, bein essentially a quiet-day phenomenon. High, cusp and one type of flat Es also predominate when magnetic conditions are quiet. The relations between auroral and retardation Es, a type of flat Es, polar blackout and magnetic activity are discussed more fully. The station appears to be exceptionally well placed for the study of ionospheric phenomena.

1534 IONOSPHERIC DRIFTS DETERMINED FROM RADIO-STAR SCINTILLATION OBSERVATIONS. P.M.Brenan.

Proc. Roy. Soc. A (GB), Vol. 256, 222-9 (June 21, 1960).

"Halley Bay Expedition" (see Abstr. 18476 of 1960). Spaced-receiver observations of radio-star scintillation were made at the Royal Society Base, Halley Bay, Antarctica, during the I.G.Y. A technique is described whereby ionospheric velocities can be deduced from the motion of the diffraction pattern on the ground. The velocities were approximately towards the west in the first part of the night, and towards the east for the rest of the night and most of the next day. The reversals in direction of motion occurred at 0030 and 1630 L.M.T. Drift speeds were of the order of 400 m/sec in the evening, falling to 100 m/sec after easterly motions were established. Both the time of midnight reversal and the drift speed correlate well with Evans's (1959) measurements of motions of auroral forms.

1535 MEASUREMENT OF POSITIVE ION DENSITY IN THE IONOSPHERE. T.Ichimiya, K.Takayama and Y.Aono.

Rep. Ionosphere Space Res. Japan, Vol. 13, No. 3, 155-76 (Sept., 1959).

The sources of error in the determination of positive ion densit in the ionosphere by means of a rocket-borne double Langmuir-prob instrument are discussed. It is concluded that the main ones can be eliminated by using a small-size meshed spherical probe. The characteristics of such a probe were investigated in a laboratory experiment. The experiments showed that a cross-ring spherical probe would be suitable for measurement of low ion density in the ionosphere. Finally an amplifier for the double probe instrument is described. D.M.Schlapp

1536 THE ARCTIC IONOSPHERE AND SOLAR ACTIVITY. N.C.Gerson.

Ann. Geophys. (France), Vol. 16, No. 2, 253-61 (1960).

Ionospheric conditions at several arctic stations have been correlated with solar activity using monthly median critical frequencies for the E, F1 and F2 layers and the 13-month mean Zürich sunspot numbers. The stations examined were Baker Lake, Churchill, College, Narsarssuak, Oslo and Point Barrow. Local noon data for each layer were utilized and, in addition, local midnight values for the F2 layer.

1537 ON THE MECHANISM OF IONIZATION OF THE SPORADIC Es LAYER IN THE IONOSPHERE. K.Bibl.

Ann. Geophys. (France), Vol. 16, No. 1, 148-51 (1960). In French.

Using a new technique of observation it can be shown that the height of Es varies in a systematic way during the "lifetime" of an Es event. If the intensity of ionization increases this height decreases.

1538 THE BELT OF EQUATORIAL SPREAD-F. A.J.Lyon, N.J.Skinner and R.W.H.Wright.

J. atmos. terrest. Phys. (GB), Vol. 19, No. 3-4, 145-59 (Dec., 1960).

The morphology of the belt of equatorial spread-F at sunspot maximum is investigated, using I.G.Y. data, for magnetically quiet and magnetically disturbed conditions respectively. The belt is found to extend from about 30°S to 30°N in magnetic latitude and to have a region of very high incidence, exceeding 90% for the early part of the night, about 20° wide in latitude and centred on the dip equator. In Africa and India there is little seasonal variation in quiet-day incidence, but a marked seasonal variation occurs in the American zone where there is a pronounced minimum in local winter. Throughout the whole belt from 30°S to 30°N there is a strong inverse correlation between spread-F incidence and magneti ivity. Moreover the post-sunset rise of the base of the layer, ch usually precedes the onset of spread-F shows a marked itive correlation with spread-F incidence within the belt. No sting theory seems adequate to account for all of these facts but eems likely that hydromagnetic disturbances are involved.

1539 MOVEMENT OF THE F-LAYER OF THE IONOSPHERE DURING BAY DISTURBANCES OF THE EARTH GNETISM. H.Kohl.

h. elekt. Ubertragung (Germany), Vol. 14, No. 4, 169-76 (April, 0). In German.

The F-layer rises during positive-going geomagnetic disturces and sinks again after the end of the disturbance. Existing ories attribute bay distrubances to an electric field of aurora gin which induces currents in the ionosphere. D.F.Martyn's theory geomagnetic storms is expanded bringing into account the innce of the neutral gas. Motional equations of the plasma olved in the explanation of the F-layer sinking can be solved approximately. From the rising movement of the F-layer the simulataneously recorded geomagnetic bay disturbance the egral can be calculated of the ionospheric conductivity over the ght. From the sinking rate of the layer after the disturbance, tral gas density can be estimated. Results of evaluations are en. J.M.Silberstein

1540 STUDY OF THE EVOLUTION OF THE IONOSPHERIC F_2 LAYER AT LEOPOLDVILLE-BINZA. P.Herrinck.

. Geophys. (France), Vol. 16, No. 1, 77-87 (1960). In French.

The present investigation of the maximum electronic density of F_2 layer shows: (1) a semi annual global variation, in phase h the variation in magnetic activity; (2) a marked semi annual iation between 09 and between 23 and 02 hours U.T. and a rked annual variation for the remaining hours; (3) a considerable e of increase with sunspot numbers between 18 and 24 hours M.T.; (4) a maximum between 21 and 23 hours corresponding h a maximum of the half thickness. Owing to the difficulties ountered in explaining these particularities only by the action photonic ionization and drift, it seems justified to consider extra ization due to corpuscules accelerated in a region near to the th.

1541 HEIGHT AND THICKNESS PARAMETERS FOR REGION F OF THE IONOSPHERE. E.R.Schmerling.

geophys. Res.(USA), Vol. 65, No. 3, 1072-3 (March, 1960).

It is pointed out that the evaluation of the height of maximum F2 ization, h_m, from ionograms, and also its physical significance, e subject to uncertainties which make it an unreliable parater. It is suggested that a more satisfactory measurement is height $h(0.9\ N_m)$ where the electron density is 90% of its ximum value; the layer thickness can similarly be measured the quantity $[h(0.9\ N_m) - h(0.5\ N_m)]$. G.M.Brown

1542 SUDDEN COMMENCEMENT IONOSPHERIC DISTURBANCES AND THE PROPAGATION OF LONG WAVES.

Haubert.

atmos. terrest. Phys. (GB), Vol. 18, No. 1, 71-2 (April, 1960). French.

This note amends an earlier note [Haubert, J. atmos. terrest. ys., Vol. 13, No. 3-4, 379 (Feb., 1959)] which stated that short ve fade-outs were always accompanied by an enhancement of long ve signals. With further work, a seasonal variation has been nd in the proportion of long wave enhancements to short wave le-outs. This ratio is large in summer and decreases in the nter. H.J.A.Chivers

1543 SCINTILLATIONS OF THE 20 Mc/s SIGNAL FROM THE EARTH SATELLITE 1958 δ II. J.Frihagen and J.Trøim.

tmos. terrest. Phys. (GB), Vol. 18, No. 1, 75-8 (April, 1960).

Time displacements between records made at two stations ced along a line parallel to the satellite track, give a measure of height of the irregularities causing scintillation. Both E and F ion irregularities have been detected in this way, and they are nd to be elongated along the earth's magnetic field lines. H.J.A.Chivers

1544 A NOTE ON THE POLAR ABSORPTION EVENT OF 11-18 MAY, 1959.

/.Eriksen, O.Holt and B.Landmark.

tmos. terrest. Phys. (GB), Vol. 18, No. 1, 78-81 (April, 1960).

Simultaneous observations at 5 high latitude stations show the ır control of the absorption observed. Considerations of layer sunrise give an indication of the height at which the radio absorption occurs. H.J.A.Chivers

1545 CHANGES IN THE FADING SPEED OF LOW-FREQUENCY RADIO WAVES. W.A.Cilliers.

J. atmos. terrest. Phys. (GB), Vol. 18, No. 4, 339-41 (Aug., 1960).

A high correlation was found to exist in winter time between the fading speed of the fast component of fading on frequencies of 70, 113 and 200 kc/s and the number of meteors incident on the ionosphere. D.M.Schlapp

1546 A POSSIBLE LONG-RANGE COMMUNICATIONS LINK BETWEEN GROUND AND LOW-ORBITING SATELLITES.

M.S.Macrakis.

J. atmos. terrest. Phys. (GB), Vol. 19, No. 3-4, 260-71 (Dec., 1960).

The ionosphere is likened to a spherical Luneberg lens which in a small region has a refractive index given by $n^2(\rho)\rho^2 = n_0^2\rho^\lambda(1 + \rho^{2\lambda})^{-2}$ (where ρ is the distance from the centre and λ is a parameter). Under certain restrictive conditions, it is shown that a ray properly injected in the ionosphere can travel long distances without entering the upper atmosphere. A method for possible injection of the rays is also discussed.

1547 FADING OF SATELLITE TRANSMISSIONS AND IONOSPHERIC IRREGULARITIES. J.Mawdsley.

J. atmos. terrest. Phys. (GB), Vol. 18, No. 4, 344 (Aug., 1960).

An alternative suggestion is offered to that put forward by Kent concerning the observations at Cambridge of a rapidly fading component on the 40 Mc/s wave radiated from Sputnik I (Abstr. 15172 of 1960), namely, that the irregularities are present to the south of Cambridge, but are oriented so as to scatter sufficient power for the rapid fading to be observed only when the satellite is in the north. A.Boksenberg

1548 CHOICE OF A PARAMETER CHARACTERIZING RADIO WHISTLERS. Y.Corcuff.

Ann. Geophys. (France), Vol. 16, No. 1, 128-39 (1960). In French.

D, the dispersion of the whistlers, which is proportional to the path-length of the energy, has been taken as their character-number. However, analysis of the long whistlers leads to considering the dispersion as frequency dependent. The specification of zero and 4 kc/s as reference frequencies seems specially interesting. The methods which may be used to determine the dispersion of any whistler in both cases are described and discussed.

1549 THE HYDROGEN ION EFFECT IN WHISTLER DISPERSION. R.E.Barrington and T.Nishizaki.

Canad. J. Phys., Vol. 38, No. 12, 1642-52 (Dec., 1960).

Four low-altitude whistlers were carefully analysed by a specially developed filtering technique. In each case the low-frequency portions of the resulting dispersion curves show similar departures from the simple $tf^{1/2}$ = const. law developed by Eckersley. The departures are found to be of the form and magnitude predicted by Storey on the assumption that the propagation is partly supported by the light hydrogen ions of the exosphere. If it is assumed that the observed deviations are due only to hydrogen ions, and that above some transitional level the positive ions are mostly, hydrogen, an estimate of 1000 km for the height of the transitional level is obtained.

1550 THE ELECTRON DENSITY DISTRIBUTION DERIVED FROM WHISTLER DATA AND FARADAY-FADING OBSERVATIONS. K.H.Schmelovsky.

J. atmos. terrest. Phys. (GB), Vol. 19, No. 1, 68-71 (Sept., 1960).

Models of the mean electron density distribution up to 1200 km have been obtained by analysis of Faraday-fading of satellite signals. Above this height such measurements become inpracticable, and whistler measurements are employed more advantageously. However, only very rough models can be derived from whistler data, because of the small amount of experimental results and the errors in the theoretical approximations. The present paper attempts to get a reliable electrondensity model by combining these two methods by the process of looking for an interpolation law which approximates, for low heights, to the results from

Faraday-fading analysis, and which also describes approximately the measured latitude dependence of the whistler dispersions.
A.Boksenberg

STATEMENT OF AGREEMENT REGARDING THE RING-CURRENT EFFECT. See Abstr. 1580

1551 A FABRY-PEROT SPECTROMETER FOR AURORAL AND AIRGLOW OBSERVATIONS. G.G.Shepherd.

Canad. J. Phys., Vol. 38, No. 12, 1560-9 (Dec., 1960).

A 1 in. Fabry-Perot interferometric spectrometer employing mechanical scanning has been constructed to operate at low order. Such an instrument gives a resolution similar to that of a grating spectrometer but has, at that resolution, a much higher light gathering power. The spectrometer is capable of resolving the sodium D lines in the twilight airglow, scanning once per minute. Some preliminary results on the variation of D_2/D_1 ratio during twilight are presented. This type of spectrometer should be useful for a number of other applications.

1552 RATE OF THE THREE-BODY ATOMIC OXYGEN REACTION FOR THE EXCITATION OF THE AIRGLOW OI (5577 A) LINE. R.A.Young and K.C.Clark.

Phys. Rev. Letters (USA), Vol. 5, No. 7, 320-1 (Oct. 1, 1960).

If the Chapman reaction: –

$$O + O + O \rightarrow O_2 + O(^1S),$$

$$O(^1S) \rightarrow O(^1D) + h\nu,$$

is to account for recently published data on airglow emission at 5577 A in the upper atmosphere, then it must proceed at a rate exceeding $10^{-34} cm^6 sec^{-1}$. Laboratory studies of this radiation show that the radiation intensity is not proportional to the cube of the atomic oxygen density; it is deduced that the reaction rate cannot exceed $10^{-36} cm^6 sec^{-1}$, so that the reaction is probably unimportant in airglow.
K.A.Thomas

1553 OBSERVATIONS OF TWILIGHT AND NIGHT SKY AIRGLOW NEAR THE EQUATOR.

D.E.Blackwell, M.F.Ingham and H.N.Rundle.
Ann. Geophys. (France), Vol. 16, No. 1, 152-3 (1960).

During the mongths of June, July and August, 1958, an expedition from the Cambridge Observatories made observations of the zodiacal light at the cosmic ray station of Chacaltaya in the Bolivian Andes. The station is situated at geographic latitude 16°4 S and geomagnetic latitude 4°9 S and being at the height of 17 100 ft, is particularly suited to optical observations of this kind. One of the purposes of the expedition was to photograph the spectrum of the zodiacal light using a spectrograph of relative aperture f/0.87 and dispersion 78 A/mm in the first order of the red region and 38 A/mm in the second order of the blue region. As the exposures were commenced soon after the end of astronomical twilight, the spectra necessarily showed twilight emission features, and this note chiefly concerns the results of measurements of the absolute intensities of these features. Some measurements of absolute intensities in spectra of the night sky are also presented.

1554 ON THE TWILIGHT OBSERVATIONS OF THE LITHIUM LINE DURING THE INTERNATIONAL GEOPHYSICAL YEAR. J.Delannoy.

Ann. Geophys. (France), Vol. 16, No. 2, 236-52 (1960). In French.

Absolute intensity measurements of the 6708 A twilight lithium line on spectra from Adelie Land, and the same for the sodium D lines allows a comparison of the quantities of neutral Li and Na atoms in the winter high atmosphere above the station in 1957 and 1958. The derivation of abundances is made by usual twilight calculations, taking into account self absorption of the resonance light by the emitting layer. The results obtained cannot indicate the origin of the observed lithium atoms without further observational evidence; nevertheless the nuclear experiments of Johnston Island might have played an important part in the 1958 observations.

1555 ORIGIN OF [OI] 5577 IN NIGHTGLOW AND IN AURORA. D.Barbier.

Ann. Geophys. (France), Vol. 16, No. 1, 143-7 (1960). In French.

The 5577 A emission in the aurora and in nightglow are two distinct phenomena, and separable by observation. At the Haut Provence Observatory the auroral component is always very weak, except low down on the horizon, and its appearance is rare. The dissymetry of histograms of the intensity of the 5577 A emission is easily explained by Chapman's theory of the nocturnal emission of this radiation by triple collisions between atoms of oxygen.

1556 A NOTE TO THE PAPER BY G.WITT, "POLARISATION OF LIGHT FROM NOCTILUCENT CLOUDS". G.Witt.

J. geophys. Res. (USA), Vol. 65, No. 7, 2199-200 (July, 1960).

The degree of polarization versus scattering angle has been calculated for spherical iron particles (radii 0.097×10^{-5} and 1.55×10^{-5} cm) at wavelengths of 4900 and 6100 A. The results have been compared with measurements made upon the scattering of light from particles in noctilucent cloud particles at Torsta in Sweden (see Abstr. 14290 of 1960). Agreement between experiments and theory was poor which leads to the conclusion that the particles in the clouds were not metallic but dielectric in nature with a possible meteoric origin. The optical system used to make the measurements is described.
R.W.Nicholls

1557 INVESTIGATIONS ON THE PERIODICITY OF RADIO REFLECTIONS FROM AURORAE. M.Tiuri.

State Inst. Tech. Res. Rep. (Finland) II, No. 4, 15 pp. (1960).

Investigations were carried out during the winter of 1959-1960, in Finland, with a narrow-beam, 100 Mc/s aurora-radar located south of the aurora belt and pointed in a fixed direction toward the magnetic north pole. It was found that the reflections from aurorae in the afternoon and evening before 21.00 hr are frequently periodic with a period of 6-8 min, whereas the power reflected from aurorae in the night after 21.00 hr seems to vary irregularly. Doppler shift measurements support the assumption that the motions of the auroral ionization regions are consistent with the mean ionospheric currents observed during magnetic storms.

1558 DISTRIBUTION OF AURORAS IN THE SOUTHERN HEMISPHERE. F.R.Bond and F.Jacka.

Austral. J. Phys., Vol. 13, No. 3, 610-12 (Sept., 1960).

Auroral data obtained during the I.G.Y. at stations in Antarctica is used to derive an auroral map for the southerm hemisphere around the epoch of maximum sunspot activity. The map (reproduced) is based mainly on observations made at Mawson, and Macquarie Island, assuming symmetry of the isoauroral contours with respect to the geomagnetic meridian passing through the dip pole.
D.R.Barber

1559 DISCUSSION OF PAPER BY R.C.BLISS, C.W.GARTLEIN D.S.KIMBALL AND D.SPRAGUE, "AURORAS, MAGNETIC BAYS, AND PROTONS". P.Bernard.

J. geophys. Res. (USA), Vol. 65, No. 2, 785 (Feb., 1960).

It is claimed that the argument put forward by Bliss et al (See Abstr. 8403 of 1960) was originally advanced by Bernard (See Abstr. 4792 of 1952).
R.W.Nicholls

1560 SOME CONSEQUENCES OF LOCAL ACCELERATION OF AURORAL PRIMARIES.

J.W.Chamberlain, J.Kern and E.H.Vestine.
J. geophys. Res. (USA), Vol. 65, No. 8, 2535-7 (Aug., 1960).

The local acceleration, in the neighbourhood of the earth, of the electrons and protons (which are the charged auroral primaries) trapped in the earth's field has been examined to explain in part aspects of the auroral morphology, spread of energy of primary electrons, occurence of aurorae in the dark hemisphere, and the auroral electrojet.
R.W.Nicholls

1561 HORIZONTAL MOVEMENTS OF VISUAL AURORAL FEATURES. S.Evans.

J. atmos. terrest. Phys. (GB), Vol. 16, No. 1-2, 191-3 (Oct., 1959).

Photographic records of the aurora taken from films exposed at 1 frame per minute at the Royal Society Base, Halley Bay, Antarctica, during the southern Winter of 1956, are analysed to show the pattern of East—West and North—South horizontal motions of visual auroral features.
R.W.Nicholls

MAGNETIC MICROPULSATIONS AND THE PULSATING JRORA. See Abstr. 1585

MOTION OF THE AURORA; DYNAMO THEORY. See ostr. 1587-8

1562 OBSERVATIONS OF NON-FIELD-ALIGNED AURORAL RAYS. M.Gadsen and C.J.Loughnan.

tmos. terrest. Phys. (GB), Vol. 18, No. 4, 332-5 (Aug., 1960).

A series of fifteen colour photographs taken at St. Andrews, tland, during the Oct. 26th, 1956 auroral display show in five of m, a ray, uniformly red in appearance, inclined at an appreciable le to other rays photographed in the same region of the sky. It is cluded that the red rays arose high in the atmosphere, isolated m other auroral activity, were much longer than wide, were non- d aligned and were a rare occurence. R.W.Nicholls

1563 AN AURORAL EMISSION IN THE 2.0-2.2 μ REGION. J.F.Noxon and A.V.Jones.

atmos. terrest. Phys. (GB), Vol. 18, No. 4, 341-3 (Aug., 1960).

A scanning infrared spectrometer was used to search for roral and airglow emissions between 1.5 and 4.0 μ. Between 9 and 2.3 μ an OH emission occurs in the airglow spectrum, and yond this the thermal background prevents observation of other atures. Between 2 and 2.5 μ N_2^+ Meinel bands would be expected occur in the auroral spectrum and the feature at 2.15 μ has been ntatively identified as the (0, 2) band. Rarely does an aurora show emission beyond 1.8 μ which is accessible to observation from e ground. R.W.Nicholls

1564 SOUTHERLY EXTENSION OF THE AURORA BOREALIS AS SHOWN BY GERMAN LAND AND SEA-OBSER- ATIONS DURING THE I.G.Y. G.Lange-Hesse.

aturwissenschaften (Germany), Vol. 47, No. 18, 423-4 (1960). In erman.

The results of extensive observations of the southern limit, ade from numerous land and sea locations between 50° N and 40° S titude, and 83° W and 148° E longitude in the period 1957-1959, ow that there is a significant dependence of the southern exten- on of bright aurorae upon the maximum value of the planetary omagnetic index K_p, reached between 18 h and 06 h UT. For lues of K_p between 0 and 7+, the southern drift of the auroral nit is ~20° of geomagnetic latitude. For $K_p \geq 8$, the drift is more pid, the geomagnetic latitude limit decreasing from 52° N for = 8, to 25° N for $K_p = 9$. D.R.Barber

1565 AURORAL RADIO ECHOES AT HALLEY BAY. D.P.Harrison.

oc. Roy. Soc. A (GB), Vol. 256, 229-33, 233-4 (June 21, 1960).

"Halley Bay Expedition" (see Abstr. 18476 of 1960). The auroral dio echoes observed at Halley Bay,Antarctica are shown to fit osely the case of specular reflection from columns of ionization gned along the local magnetic field at a height of about 100 km. e diurnal variations in activity are presented and the daily dura- ns of activity compared with those at Jodrell Bank and with the ily sum of the planetary magnetic K-indices, K_p.

1566 AURORAL ECHOES IN THE IONOGRAMS OBTAINED IN THE MINAURORAL REGION. Y.Nakata.

p. Ionosphere Res. Japan, Vol. 12, No. 1, 1-5 (March, 1958).

On three occasions, echoes were observed on ionosonde equip- ent located at 25.5° N which had the characteristics exhibited by roral ionization observed at higher latitudes. The events, occurr- g on September 13 and September 21, 1957 and February 11, 1958, e described in some detail. Visual aurorae were seen at this itude on two of these days. H.J.A.Chivers

1567 THE OUTER RADIATION BELT AND AURORAE. H.Liemohn.

ture (GB), Vol. 188, 394-5 (Oct. 29, 1960).

Additional evidence is presented to support the validity of the model suggested by Rees and Reid (Abstr. 4813 of 1960) to explain the diurnal variation in the latitude of emission of auroral H-lines. It is shown also that this same model may be invoked to explain certain characteristics of aurorae that have not been understood hitherto. D.R.Barber

1568 MEASUREMENT OF RADIATION IN THE LOWER VAN ALLEN BELT. F.E.Holly and R.G.Johnson.

J. geophys. Res. (USA), Vol. 65, No. 2, 771-2 (Feb., 1960).

Preliminary results obtained from a package of 8 Geiger counters, collimated and shielded with different absorber thicknesses, flown in an Atlas missile which reached a peak altitude of 990 km. Methods of distinguishing between electrons and protons are suggested. G.M.Brown

1569 MAXIMUM TOTAL ENERGY OF THE VAN ALLEN RADIATION BELT. A.J.Dessler and E.H.Vestine.

J. geophys. Res.(USA), Vol. 65, No. 3, 1069-71 (March, 1960).

Consideration of the relationship between the energy stored in trapped radiation and corresponding changes in the geomagnetic field show that for a fractional external contribution to the field of 1% at the earth's surface the maximum total energy contained in the Van Allen radiation belt will be of the order of 6×10^{15} joules. Possible explanations of the observed solar cycle and annual variations of the geomagnetic field in terms of the effect of trapped radiation are also considered. G.M.Brown

1570 LATITUDE AND ALTITUDE DISTRIBUTION OF GEOMAGNETICALLY TRAPPED PROTONS. S.F.Singer.

Phys. Rev. Letters (USA), Vol. 5, No. 7, 300-3 (Oct. 1, 1960).

Continuation of earlier work on the nature and properties of radiation-belt particles. A theory for the proton injection coefficient is derived and is used to calculate the latitude and altitude dependence of the trapped protons as seen by an omnidirectional detector having (i) a lower energy limit of 30 MeV to correspond to a simple thin-walled Geiger counter, and (ii) 75 MeV to correspond to a lead-shielded counter telescope. The contours of equal counting rate show a remarkable resemblance to contours which have been obtained experimentally for these cases. A.Boksenberg

1571 DIFFUSION OF PARTICLES IN THE EARTH'S RADIATION BELTS. N.Herlofson.

Phys. Rev. Letters (USA), Vol. 5, No. 9, 414-16 (Nov. 1, 1960).

A theoretical study is presented of the diffusion of charged particles injected into the geomagnetic field well beyond the outer radiation belt and subsequently scattered by fluctuating electric or magnetic fields. Observations with Pioneer IV are compared with theoretical distribution curves and show good agreement. A.Boksenberg

GEOMAGNETISM

1572 GEOMAGNETIC OBSERVATIONS AT HALLEY BAY [ANTARTICA]. J.MacDowall.

Proc. Roy. Soc. A (GB), Vol. 256, 219-21 (June 21, 1960).

"Halley Bay Expedition" (see Abstr. 18476 of 1960). The annual variation of geomagnetic activity is described on the basis of monthly mean K-indices for three selections of days according to activity. The difference between the diurnal variation of geomagnetic activity, as defined by K-indices, in June and December is shown to be due to a universal effect accounted for by the annual change in the diurnal variation of the angle between the earth's geomagnetic axis and the line joining the sun and earth. The observed field changes in winter (May, June, July) are interpreted as being due to a disturbing line current in the ionosphere; the diurnal variation and movement of this current are described.

1573 A NEW SYSTEM OF MAGNETIC COORDINATES FOR THE STUDY OF THE UPPER ATMOSPHERE: THE COORDINATES OF THE EQUATORIAL RING.

P.N.Mayaud.
Ann. Geophys. (France), Vol. 16, No. 2, 278-88 (1960). In French.

Because of the part played in phenomena of corpuscular origin by the lines of force of the real magnetic field, it is proposed that these phenomena be classified in their studies by substituting for the dipole-coordinates a representation of the real field obtained from the extremities of the lines of force of the real field which issue from circumferences of the equatorial plane. With the aid of calculations based on harmonic spherical analysis carried out by Hultqvist, charts are drawn which permit the coordinates in this new system of any point on the earth's surface to be easily determined. Some examples justify the soundness of this substitution.

1574 SOME CONTRIBUTIONS TO THE STUDY OF THE EARTH'S MAGNETIC FIELD IN TRANSYLVANIA.

G.Atanasiu, D.Zugrăvescu, I.Bucur and T.Neştianu.
Stud. Cercetari Fiz. (Roumania), Vol. 8, No. 1, 9-15 (1957).
In Roumanian.

A comprehensive magnetic survey was made; in the Sărmaş—Cluj—Oradea region of Transylvania, of the absolute magnitudes of D, H, and I at 10 stations. A positive anomaly, extending eastwards through the region, was found and the secular variation over the last 14 years in the parameters quoted was calculated. The results of the measurements of the vertical component are in good agreement with other work on the magnetic grid of Transylvania.

S.J.St-Lorant

1575 CONTRIBUTIONS TO THE GEOMAGNETIC STUDY OF TRANSYLVANIA. ANNUAL SURVEY, 1956.

G.Atanasiu, D.Zugrăvescu and I.Bucur.
Stud. Cercetari Fiz. (Roumania), Vol. 8, No. 4, 469-78 (1957).
In Roumanian.

The parameters D, H, and I were measured in a part of North Transylvania as a contribution to an extensive geomagnetic mapping programme. Magnetic profiles were obtained of about 800 km^2 bounded by Boudin, Zau, Sàrmas and Sàrmăşel, a region particularly rich in gas domes. A definite correlation was found to exist between the location of the domes and the enhancement of the magnetic parameters in the westerly direction of the plateau. A local quasi-elliptical anomaly of about 150 km^2 was also detected in the Crasna district.

S.J.St-Lorant

1576 DISCUSSION OF PAPER BY I.R.SHAPIRO, J.D.STOLARIK, AND J.P.HEPPNER, "THE VECTOR FIELD PROTON MAGNETOMETER FOR I.G.Y. SATELLITE GROUND STATIONS".

J.H.Nelson.
J. geophys. Res. (USA), Vol. 65, No. 8, 2551-2 (Aug., 1960).

Shapiro et al. (Abstr. 14161 of 1960) claim for the proton precession magnetometer an accuracy in the measurement of magnetic declination and inclination comparable to that obtained in the best observatories. To refute this suggestion, the accuracies claimed are compared with those claimed by the operators for various instruments at the Fredericksburg and Tucson observatories.

D.M.Gilbey

1577 AUTHORS' REPLY TO THE PRECEDING DISCUSSION.

I.R.Shapiro, J.D.Stolarik and J.P.Heppner.
J. geophys. Res., Vol. 65, No. 8, 2553-4 (Aug., 1960).

The estimated errors tabulated by Nelson (see preceding abstract) for observatory equipment are not properly comparable with the authors' estimates for the proton precession magnetometer. Several sources of error in the observatory measurements are listed which may have been overlooked and which should be included in a fair comparison.

D.M.Gilbey

1578 AN ANALYSIS OF ROCK MAGNETIC DATA.

P.M.S.Blackett, J.A.Clegg and P.H.S.Stubbs.
Proc. Roy. Soc. A (GB), Vol. 256, 291-322 (July 5, 1960).

The data obtained from numerous palaeomagnetic measurements made during the past decade have shown that while the geologically younger rock formations are magnetized in directions close to that of the present earth's magnetic field, the remanent magnetic polarizations of older rocks depart markedly from this pattern. These observations are widely held by many workers to suggest that the main continental land masses have undergone movements relative to one another during the past. The present paper gives an account of a new analysis of the available data, making a minimum number of theoretical assumptions about the ways in which the rocks became magnetized and about the origin of the geomagnetic field. The results of this analysis strongly support the supposition that the observed wide divergence between the directions of the remanent magnetic vectors of older rocks and that of the present earth's field is systematic, and not a result of purely random processes occurring throughout geological time. The most reasonable explanations of the phenomenon appear to be that (a) the directions of magnetization of the earlier rocks have been changed by some widespread physical or geological processes since the time of their formation, (b) the earth's magnetic field has had strong multipolar components in past geological ages, (c) a relative drift of the continents across the earth's mantle has occurred. Of these hypotheses, (c) appears to be the most plausible. On the tentative assumption that the rock magnetic results can be explained by continental drift, it is possible to estimate the ancient latitude and the orientation relative to the earth's rotational axis, of each continent, although by palaeomagnetic measurements alone changes in relative longitude cannot be revealed.

1579 THE REMANENT MAGNETISM OF SOME RECENT VARVED SEDIMENTS.

D.H.Griffiths, R.F.King, A.I.Rees and A.E.Wright.
Proc. Roy. Soc. A (GB), Vol. 256, 359-83 (July 5, 1960).

Some unconsolidated water-laid sediments acquire a remanent magnetization as a result of the orientation during settling of the small fraction of their particles that have a permanent magnetic moment. Their alignment is affected by factors other than the direction of the geomagnetic field, such as the slope of the bed on which they are deposited, and the velocity with which the water moves over it. The paper describes measurements of the remanence of Swedish and Icelandic varved sediments, with average particle sizes lying between 5 and 25 μ, in which these factors were studied. Measurements of the remanence of these sediments redeposited in the laboratory under controlled conditions were also made. In these artificially deposited sediments the inclination of the remanence may be some 20° less than that of the magnetic field, but this "inclination error" seems to be never more than 5 to 10° in natural sediments. In neither case was the dependence of inclination error on particle size suggested by earlier work confirmed. Under both natural and artificial conditions deposition on a sloping bed produces a deviation of the remanence from the direction for deposition on a horizontal surface. The direction of rotation of the remanence is the same as that produced by tilting a bed subsequent to deposition. The deviation is less under natural than under artificial conditions, never exceeding about twice the angle of dip of the bed. Experiments on deposition in running water indicate that velocities up to about 30 cm/sec produces deviations of the remanence of up to about 20° in a direction related to that of the current flow, the magnitude of the effect being almost independent of velocity over the range of velocities between 5 and 30 cm/sec. Size and shape analyses of the sediments show that the magnetic particles have a size distribution very similar to that of the sediment as a whole, and that they are not clearly divided into well-contrasted groups of spherical and plate-like particles, as was suggested in an earlier paper. A theory is proposed to account for the known facts of depositional magnetization. Deviations of the remanence from the field direction are explained mainly as a result of the rolling of particles on the bed during the last stage of settling. To a limited extent quantitative agreement between theory and observation is attained, but the process is clearly too complex to be adequately described in simple geometrical terms. It has not therefore been found possible to use the theory for the purpose of prediction. From a review of the evidence it would seem to be possible in principle to determine the magnetic secular variation from varved sediments, but a very large number of experiments would be needed for useful results to be obtained.

1580 STATEMENT OF AGREEMENT REGARDING THE RING-CURRENT EFFECT.

C.O.Hines and E.N.Parker.
J. geophys. Res. (USA), Vol. 65, No. 4, 1299-1301 (April, 1960).

An earlier disagreement between the authors on the rate at

ich a decrease in field can be propagated through the earth's exo-
here is outlined with reference to two extreme models. A new
del is described, explaining the origin of the ring current, and on
s agreement has been reached. A rapid propagation of the
turbances produced is consistent with the main phase of a geo-
gnetic storm.
A.H.Gabriel

1581 DESCRIPTION OF THE EQUIPMENT OF A STATION FOR RECORDING VERY FAST CHANGES IN THE RTH'S MAGNETIC FIELD.

H.Fournier.
R.Acad. Sci. (France), Vol. 251, No. 5, 671-3 (Aug. 1, 1960).
French.

The station at Nivernais, a branch of the Centre d'Études
ophysiques, is equipped with mu-metal bar type induction magneto-
eters. The electronic amplification system has a very low back-
ound noise level with an exceptional sensitivity at taining 1/2000
mma/mm of writing speed for periodic variations of 4.5 sec duration.
ree pass bands cover the total interval from 0.025 to 30 sec.
libration is by means of an auxiliary ultra-linear magnetic field
known amplitude and of variable period.
S.J.St-Lorant

1582 ANALYSIS OF THE MAGNETIC AND TELLURIC EFFECTS OF THE "ARGUS EXPERIMENT" ECORDED BY FRENCH STATIONS.

Eschenbrenner, L.Ferrieux, R.Godivier, R.Lachaux, H.Larzillière
Lebeau, R.Schlich and E.Seizer.
n. Geophys. (France), Vol. 16, No. 2, 264-71 (1960). In French.

The "Argus Experiment" (three high-altitude small nuclear
tonations fired ~480 km above the South Atlantic Ocean), pro-
ced artificial magnetic and telluric perturbations of the earth's
ld, which were received very distinctly at six French stations
dely spread over the earth between France and the Antarctic.
mparison of these records with publications by the American
ganizers of the experiment (Abstr. 10427 of 1960) reveals
e unexpected fact that pulsed magnetic signals like those
iginated by the detonations (a dozen irregular oscilla-
ons, of period 1-3 secs), can travel at great speed and without
uch attenuation in all directions, across or along the earth's
agnetic field lines. For this reason, and as a start for subsequent
udies, a detailed computation of the signals as they were recorded,
reported and tabulated followed by photographic reproductions of
e original records.

1583 MAGNETIC AND TELLURIC PERTURBATIONS RECORDED AT TAMANRASSET FOLLOWING THE UCLEAR HIGH ALTITUDE EXPLOSIONS CALLED "EXPERI-ENT ARGUS" (AUGUST-SEPTEMBER 1958).

Launay and M.Beccaria.
n. Geophys. (France), Vol. 16, No. 2, 289-90 (1960). In French.

1584 A NOTE ON THE AMPLITUDE OF CERTAIN PULSATORY MAGNETIC PERTURBATIONS.

renet.
Geophys. (France), Vol. 14, No. 4, 530-2 (1958). In French.

The statistical distribution of certain magnetic perturbations
ng the form of damped oscillations shows that the reduction in
number of perturbations during the day can be explained by a
rce of damping. The fact that there is no preferential
litude shows that the threshold at which the oscillations are
ased is due to the importance of the origin of the perturbation
bably the importance of ionized clouds arising from the sun).
D.J.Oliver

1585 MAGNETIC MICROPULSATIONS AND THE PULSATING AURORA.

W.H.Cambell.
geophys. Res. (USA), Vol. 65, No. 2, 784 (Feb., 1960).

Preliminary observations show some correlation between micro-
sations both of the earth's magnetic field and of the intensity of
3914 A N_2^+ band and the 5577 A OI line of the auroral spectrum at
llege, Alaska.
R.W.Nicholls

1586 MAGNETIC BAYS AT MACQUARIE ISLAND.

C.S.Robertson.
Austral. J. Phys., Vol. 13, No. 3, 470-6 (Sept., 1960).

Polar magnetic bays were the most striking feature of magnetic records obtained by the Australian National Antarctic Research Expeditions (ANARE) at Macquarie Island. Negative bays were more numerous than positive bays and had greater amplitudes and durations. As a rule, negative bays commenced about magnetic midnight whereas positive bays commenced about 5 hr earlier. A daily reversal in direction of the bay-producing currents was indicated and the time at which this reversal took place appeared to vary with the seasons. During magnetically disturbed periods the ratio H-bay amplitude to Z-bay amplitude increased, indicating a northward movement of the bay-producing currents. At the same time aurorae seen from Macquarie Island lay further north in the sky than usual. See also two following abstracts.

1587 MOTION OF THE AURORA AND MAGNETIC BAYS.

F.R.Bond.
Austral. J. Phys., Vol. 13, No. 3, 477-82 (Sept., 1960).

Observations from the ANARE station at Macquarie Island showed that the development of an auroral display was characterized by a slow northward drift, east to west longitudinal motion, and an associated positive bay in the horizontal component magnetogram in the evening hours. This was followed by a sudden change in structure of the aurora and appearance of a negative bay. The negative bay persisted for some hours, accompanied by west to east longitudinal motion and slow southward drift of the aurora. The colatitude of the northern limits of the aurora was shown to be strongly dependent on level of geomagnetic disturbance. It is suggested that the observed motions are the mass motions of electrons which constitute the magnetic-bay-producing current within the boundaries of the auroral form. See also preceding and following abstracts.

1588 A DYNAMO THEORY OF THE AURORA AND MAGNETIC DISTURBANCE.

K.D.Cole.
Austral. J. Phys., Vol. 13, No. 3, 484-97 (Sept., 1960).

A model of an aurora regarded as a plane slab of highly ionized air parallel to the geomagnetic field within the ionosphere is examined. The model is stable in the presence of a wind of neutral molecules which, blowing the slab across the geomagnetic field, generates an electric polarization field perpendicular to its faces and a current along its length. This current is concentrated in a small height range and is chiefly due to electron drift. The aurora moves normal to itself with a speed of the same order as the wind speed, while the drift carries its luminosity and ionization pattern along its length at a speed an order of magnitude greater. Measurements of these speeds will permit determinations of collision frequencies of ions and electrons within the aurora. Assuming, in the equatorial vicinity of the auroral zone, an equatorwards wind in the evening and a polewards wind in the night and morning hours, it is possible to explain the major movements of the aurora and associated bay type magnetic disturbances. It is suggested that the magnetic disturbance indices K and K_p are indicators of wind speed. A likely mechanism of maintenance of luminosity and ionization in the aurora is outlined. The general features of magnetic disturbance current systems within the auroral zone are briefly considered in relation to the theory and it is suggested that the aurorae are visible manifestitations of the current flow. Qualitative speculation on a possible source of energy for winds in the polar dynamo region leads to a unified account of the Van Allen radiation belts, aurorae, and some (low latitude) airglow. See also two preceding abstracts.

1589 THE CORRELATION BETWEEN THE GEOMAGNETIC DISTURBANCES OF 1950 AND CALCIUM PLAGES.

O.N.Mitropol'skaya.
Astron. Zh.(USSR), Vol. 36, No. 4, 616-19 (1959). In Russian.
English translation in: Soviet Astron.—AJ (USA), Vol. 3, No. 4, 601-5 (Jan.-Feb., 1960).

The correlation between geomagnetic disturbances (March-December 1950) and Ca$^+$ plages, which passed across the centre of the solar disk or near it, was studied. For the same period a statistical curve was obtained by the method of superposed epoch. This curve confirms the results of the individual correlations. The geomagnetic disturbances lag behind the C.M.P. of the plages by

3.5 days on the average and the maximum of geomagnetic activity is at phase $+5^{d}$. The same follows from Waldmeier's data (1956) if the indices C are used. The introduction of indices C* and P* in by Waldmeier does not seem to be justified. A shift of the correlation curves is due to the decrease of the velocity of corpuscles toward the minimum of solar activity.

1590 THE STATISTICS OF GEOMAGNETIC DISTURBANCES AND ACTIVE SOLAR REGIONS.

A.S.Dvoryashin.

Astron. Zh. (USSR), Vol. 36, No. 4, 620-2 (1959). In Russian. English translation in: Soviet Astron.—AJ (USA), Vol. 3, No. 4, 606-8 (Jan.-Feb., 1960).

The method of superposed epoch is applied to geomagnetic disturbances for the period 1942-1944. The moment of the CMP of plages plotted on the maps given by Mustel' and Dvoryashin (Abstr. 6596 of 1958) is taken as the zeropoint. Curves are obtained for the period May 1942-April 1943, the period May 1943-May 1944, and the complete period 1942-1944. In 1943 the radiality of streams from plages was disturbed. Correspondingly, two maxima and one minimum are obtained if the superposed epoch method is applied to plages in "favourable" and in "unfavourable" hemispheres of the sun.

1591 A STUDY OF SOLAR CORPUSCULAR STREAMS BASED ON WORLD-WIDE GEOMAGNETIC DISTURBANCES OBSERVED DURING THE I.G.Y.

M.S.Bobrov.

Astron. Zh. (USSR), Vol. 36, No. 6, 1028-36 (1959). In Russian. English translation in: Soviet Astron.—AJ (USA), Vol. 3, No. 6, 943-50 (May-June, 1960).

Analysis of I.G.Y. geomagnetic data reveals three main zones of magnetic disturbance: (1) a belt of synchronous activity at geomagnetic latitude, $<\sim 50^{\circ}$, and $\sim$10 000 km wide (the source of this activity must lie at a distance >1 earth radius); (2) two belts of localized disturbance stretching from zone (1) to the boundary of the nearest polar cap, and in which there is normally no synchronous activity; (3) two zones of permanent disturbance coincident with the geomagnetic N. and S. polar caps in which there is an almost complete absence of magnetically quiet periods, and a daytime maximum of activity. Detailed features of the three zones are described and discussed. D.R.Barber

1592 A NOTE ON DAYTIME ENHANCEMENT OF THE AMPLITUDE OF GEOMAGNETIC-STORM SUDDEN COMMENCEMENTS IN THE EQUATORIAL REGION.

H.Maeda and M.Yamamoto.

J. geophys. Res. (USA), Vol. 65, No. 8, 2538-9 (Aug., 1960).

Graphs are given of the ratios of the amplitude of the horizontal components of s.c.'s at ten stations in the equatorial region to those at Honolulu. Daytime enhancement of s.c.'s occurred only at those stations less than about 20° in dip, and abnormally large amplitude occurred at stations within about 3° in dip, indicating that a s.c. consists of two parts: one of atmospheric and the other of outer-atmospheric origin. J.Dutton

1593 SOME OBSERVATIONS OF THE GEOMAGNETIC FLUCTUATION SPECTRUM AT AUDIO FREQUENCIES.

J.R.Heirtzler, D.L.Nichols and R.A.Santirocco.

J. geophys. Res. (USA), Vol. 65, No. 8, 2545-7 (Aug., 1960).

Graphs of geomagnetic fluctuation spectra in the range 10 to 10 000 c/s at two sites in the north eastern United States are given and compared with earlier results [Abstr. 3540 of 1948; U.S. Naval Ordnance Lab., Navord Rep. 4009 (1957); Abstr. 5217B of 1957, Proc. Inst. Radio Engrs, Vol. 45, No. 6, 787-94 (June, 1957)]. Computations of cross-correlation coefficients between the envelopes of noise observed simultaneously at two frequencies show that there is a loss of time coherence between the fluctuations near 2 kc/s and those at other frequencies. J.Dutton

1594 ON THE MAGNETIC TIME DEPENDENCE OF THE AURORAL ZONE CURRENTS.

B.Hultqvist and G.Gustafsson.

J. atmos. terrest. Phys. (GB), Vol. 19, No. 3-4, 246-59 (Dec., 1960).

The difference in geomagnetic time between Kiruna (Sweden) and College (Alaska) for the evening passage of the geomagnetic horizontal component through the zero-disturbance level was evaluated in respect of 386 days with well-developed current systems during the period from 1950 to 1953. A significant averag difference of 42 min was found. The higher spherical harmonic terms of the geomagnetic field may account for 28 min, but even the remaining time difference is statistically significant. It may be due, it is suggested, to a slow rotation of the nodes of the auroral zone current system (approximately one-fourth of a degree per hour) with respect of the sun in a direction counter to the earth' rotation. The studies showed no secular variation in the geomagnetic time difference, but a pronounced seasonal variation. This may be attributed to a seasonal variation in the velocity of rotation of the horizontal auroral zone current system.

1595 THREE-DIMENSIONAL CONSIDERATION FOR CURRENT-SYSTEM OF GEOMAGNETIC VARIATIONS. I(2). CURRENT FLOW FOR POLAR ELEMENTARY STORM WITHIN A SPHERICAL CONDUCTING SHELL.

N.Fukushima and R.Maeda.

Rep. Ionosphere Space Res. Japan, Vol. 13, No. 4, 267-72 (Dec., 195

For Pt I(1), see Abstr. 21341 of 1960. The magnetic field produced by three-dimensional electric current flow in the ionosphere is studied in the case of a polar elementary storm. By means of a very simple assumption of constant and isotropic electrical conductivity throughout the ionosphere of finite-thickness, the toroidal and poloidal magnetic fields within the conducting region are compared with each other. So far as such a simple model for the ionosphere is acceptable, the present interpretation for the results of experimental measurements of the earth's magnetic field in the upper atmosphere by rocket sounding is correct, because the chang with height of the toroidal magnetic field appearing only in the ionosphere as well as the poloidal magnetic field contributes to the stee change of magnetic field accompanying the penetration of the electr current sheet.

1596 THREE-DIMENSIONAL CONSIDERATION FOR CURRE SYSTEM OF GEOMAGNETIC VARIATIONS. II. Sq-FIELD.

A.Nishida and N.Fukushima.

Rep. Ionosphere Space Res. Japan, Vol. 13, No. 4, 273-82 (Dec., 19

The equivalent electric current-system for the geomagnetic S variation is examined on the basis of a three-dimensional model, where the thickness of the conducting region is taken into account. The conducting region is assumed to be a spherical layer of 70 km thick with homogeneous and isotropic electrical conductivity, and the wind velocity independent of height. The result shows that the poloidal electric current and the associated toroidal magnetic fiel appearing only in a three-dimensional treatment are less than one-tenth in magnitude of the total current and field. It is concluded therefore that the two-dimensional calculation hitherto made is approx mately valid, so far as the vertical thickness of the conducting layer is small compared with the horizontal extension of the curre bearing layer of homogeneous conductivity.

1597 INFLUENCE OF HALL EFFECT ON THE INDUCED CURRENT IN THE EARTH OWING TO MAGNETIC DISTURBANCES.

J.S.Chatterjee.

Sci. and Culture (India), Vol. 26, No. 2, 92-4 (Aug., 1960).

The author's previous suggestion (Abstr. 7860, 8493 of 1956) for explaining the magnetization of the earth by a cumulative proc due to magnetic storms through geological ages was criticized by Rikitake (Abstr. 6525 of 1958) on the grounds of the time needed (10^{2200} yrs) for the build-up of the observed field. In a re-examina of the question the author suggests that when induced currents flow in the mantle due to world-wide magnetic disturbances a Hall effec is developed due to the steady component of the earth's field resulting in a radial inward or outward movement of the electrons which gives rise to non-linear conductive properties in the mantle. There is a rectification effect and the east-west currents are slightly greater than those in the reverse direction. The successiv uni-directional currents gradually permeate to the liquid core wher on account of the long relaxation time (10^{12} sec) they contribute to a build-up of a strong current. It is postulated that the Hall effect greatly accelerates the processes for the building up of the earth's magnetization previously suggested by the author. Details of calcu lations, which have been made apparently with the perturbation method, are not given but it is stated that sudden commencements can maintain a current of 10^{9} e.m.u. in the core. D.S.Parasn

THE GEOMAGNETIC AND COSMIC-RAY EQUATORS.

See Abstr. 563.

BIOPHYSICS . PHYSIOLOGICAL PHYSICS

1598 MAN AND RADIATION.
R.Schulze.

htttechnik (Germany), Vol. 12, No. 8, 443-8 (Aug., 1960). In
rman.

Radiation of all wavelengths is emitted from the sun and outer
ce, but all except two bands of wavelengths are stopped by the
th's atmosphere. One of these bands covers the visible and
r u.v.; the other consists of wavelengths from about 3 cm to
m, but the energy in this band is comparatively very small.
e possible effects on the human organism of the various radia-
ns, including those which originate on the earth or in the atmo-
ere, are described in some detail. J.W.T.Walsh

1599 PROTECTION AGAINST RADIATIONS FROM SEALED GAMMA SOURCES.

ndb. Nat. Bur. Stand.(USA), No. 73, 70 pp. (1960).

The pattern of this handbook follows fairly closely that of the
Handbook 54, which it supersedes, but it includes the changes
ecommended maximum permissible exposure levels and other
information, particularly on protection in teletherapy. Greater
tinction is made between mandatory and advisory recommenda-
ns. S.E.Hunt

DEPOSITION OF LYCOPODIUM SPORES UPON GLASS SLIDES
XPOSED IN A WIND TUNNEL. See Abstr. 164

Hearing . Speech

1600 THE SPECTRAL STRUCTURE OF THE GERMAN /r/-ALLOPHONE. W.Meyer-Eppler.

ustica (Internat.), Vol. 9, 247-50 (1959) [=Akust. Beihefte, No. 1,
59)]. In German.

In order to estimate the spectra of allophonic variants of the
rman /r/ phoneme, "visible speech analyses" were made of
cially chosen words, spoken by people living in the environs of
ogne. The allophones [R] and [ɒ] are characterized by move-
nt of the first and second formants — centering for the former
nd 430 and 1100 c/s and for the latter round 650 and 1250 c/s.
e distinctive characteristics of unstressed final /er/ and final
are found and related to unstressed final /e/.

1601 ACOUSTIC ANALYSIS AND SYNTHESIS OF SPEECH WITH APPLICATIONS TO SWEDISH. G.Fant.

csson Tech. (Sweden), Vol. 15, No. 1, 3-108 (1959).

The theory of short-time frequency analysis by means of
ctrographic devices is outlined with an emphasis on the formal
tions between the function of a band-pass filter and Fourier
gral calculus. Methods of evaluating the transient response and
the temporal sampling characteristic of low-pass and band-pass
rs are reviewed. The formulae developed by Laurent are applied
imple filters. The more important techniques of acoustic speech
ysis and the essentials of the speech wave signal structure are
cribed. A theoretical analysis of the vocal tract transmission
racteristics is made on the basis of the theory of electrical trans-
sion lines and Laplace transforms. Pole-zero specifications of
sfer functions as well as inverse transforms are discussed and
ied to problems of speech specification and the design of electri-
analogues to the vocal tract. A few practical applications to
onance analogue synthesizers are discussed. Results from earlier
k on the acoustic analysis of Swedish speech sounds are summa-
d and compared to American data. Emphasis is laid on the con-
ction of vowel diagrams from acoustic data. Experiments on
tone-vowel associations are reported on. The distribution of frequency-intensity formant data of speech is discussed with regard to equal loudness contours and perception criteria.

1602 ANALOG MEASUREMENTS OF SOUND RADIATION FROM THE MOUTH. J.L.Flanagan.

J. Acoust. Soc. Amer., Vol. 32, No. 12, 1613-20 (Dec., 1960).

Free-field measurements of the sound radiated from the mouth of a life-sized mannequin are described. A transducer installed in the head of the dummy is calibrated to produce a known acoustic volume velocity at the lips. The sound field in vertical and horizontal planes through the head is explored with a pressure microphone. Measurements of pressure magnitude and phase are made for frequencies of 250, 500, 1000, 2000, and 4000 c/s. The results are compared with the sound distributions for a simple spherical source, and for a small piston in a sphere of 9 cm radius. Over the frequency range investigated, and within a solid angle of about π sr centred on the mouth axis, the relations for the simple source are found to describe the measured magnitudes within approximately 3 dB, and the measured phases within approximately 30°. The results are also compared with previously reported pressure distributions for speech. Some brief comment is devoted to approximating the radiation impedance of the mouth.

1603 SPEECH PROCESSING BY THE SELECTIVE AMPLITUDE SAMPLING SYSTEM.

L.R.Spogen, H.N.Shaver, D.E.Baker and B.V.Blom.

J. Acoust. Soc. Amer., Vol. 32, No. 12, 1621-5 (Dec., 1960).

This is a technique in which the input speech waveform is sampled at the time of its maxima and minima. The original wave is reconstructed from its samples by means of a box-car circuit followed by suitable filtering. The maxima and minima are determined from the zero crossings of the differentiated speech wave. Centre clipping is employed to provide amplitude discrimination and a reduction in the average sampling rate. The intelligibility of speech processed by the system is compared with that for clipped differentiated speech and the original speech. "Quality" tests attempted to measure the ability of listeners to distinguish between words processed by the selective amplitude sampling system and a system in which the original words were filtered to a pass band of 300 to 3000 c/s. Distributions were obtained of the sampling rate averaged over 1 and 10 sec intervals. Word intelligibility and sampling rate are also related to the degree of centre clipping in the sampler. The degree of centre clipping is measured in terms of an r.m.s. voice-to-threshold ratio. The word intelligibility scores on the selective amplitude sampling system had a mean of 93.8% and a standard deviation of 4.3%. In addition, 97% of all the test scores were equivalent to 100% sentence intelligibility. The results of the "quality" tests indicate that at least 36% of the time, the listeners were unable to distinguish between the selective amplitude sampling system and the filtered system. The average sampling rate necessary for 100% sentence intelligibility is approximately 1600 samples/sec. This rate corresponds to an r.m.s. voice-to-threshold ratio of 7 dB.

1604 INVESTIGATION OF THE DISCRIMINATION OF CZECH SPEECH IN CINEMA HALLS BY THE SYLLABIC METHOD. B.Klimesh.

Akust. Zh. (USSR), Vol. 5, No. 4, 415-19 (1959). In Russian.
English translation in: Soviet Physics—Acoustics (USA), Vol. 5, No. 4, 426-30 (April-June, 1960).

The results of articulation tests on speech discrimination, with the application of various articulation tables, are reported.

1605 FREQUENCY-DIFFERENCE LIMENS AS A FUNCTION OF TONAL DURATION.

Lyan Chzhi-an' [Liang Chih-an] and L.A.Chistovich.
Akust. Zh. (USSR), Vol. 6, No. 1, 81-6 (1960). In Russian. English translation in: Soviet Physics—Acoustics (USA), Vol. 6, No. 1, 75-80 (July-Sept., 1960).

The dependence of frequency-difference limens on tonal duration is investigated. The results reveal different forms of the relationship in the regions of short ($t < T_1$), medium ($T_1 < t < T_2$), and long ($T_2 < t$) durations. The change in T_1 and T_2 with a change in the signal frequency is studied. The authors discuss the possible physiological interpretation of the constants T_1 and T_2.

1606 DETERMINATION OF THE NORMAL THRESHOLD OF HEARING FOR PURE TONES IN MONAURAL LISTENING WITH THE HELP OF HEADPHONES.

H.Mrass and H.G.Diestel.
Acustica (Internat.), Vol. 9, No. 2, 61-4 (1959). In German.

At the Physikalisch-Technische Bundesanstalt, Brunswick, a determination of the normal threshold of hearing by earphone listening was undertaken on a group of 70 otologically normal subjects (140 ears) of ages between 18 and 30 years. The results are given in terms of normal equivalent threshold sound pressures and normal threshold sound pressures at entrance to the external auditory meatus.

1607 THE THRESHOLD OF HEARING AS A FUNCTION OF AGE. R.Hinchcliffe.

Acustica (Internat.), Vol. 9, No. 4, 303-8 (1959).

The threshold of hearing was measured at frequencies ranging from 125 to 12 000 c/s on a random sample, stratified for age and sex, that had been drawn from a representative rural population in Great Britain. Clinically abnormal ears were discarded from the analysis. For all age groups, there was a significant difference between the thresholds for the two sexes at 3, 4 and 6 kc/s. For the older age groups, there was also a significant sex difference at 2 and 8 kc/s also. This sex difference is most probably attributable to acoustic trauma. The curves showing threshold of hearing as a function of age that are presented for clinically normal female ears may be considered as pure presbyacusis curves.

1608 THE DIFFERENTIAL INTENSITY THRESHOLD IN THE PRESENCE OF A CONTRALATERAL TONE OF DIFFERENT FREQUENCY. R.Chocholle.

Acustica (Internat.), Vol. 9, No. 4, 309-15 (1959). In French.

The differential thresholds in presence of a constant contralateral tone of a different frequency on the opposite ear were studied by the method of constant stimuli. The results show that the differential thresholds in presence of this contralateral tone are lower than those of a single ear. A tone of a different frequency on the opposite ear is therefore helpful.

1609 CONTRIBUTION TO THE STUDY OF THE PROBLEM OF THE TONAL SELECTIVITY OF THE EAR.

L.Pimonow.
Acustica (Internat.), Vol. 9, No. 5, 345-52 (1959). In French.

Given that the spectral analysis by the basilar membrane of the ear, functioning as "camera acustica", is not selective, the author explains the high differential faculty of the ear as an effect of nervous fluxes, producing a pressure on the organs of Corti. The propagation of the wave on the basilar membrane towards the helicotrema produces out-of-phase components in these fluxes. Given that the fluxes are more efficaceous as these phases approach each other, the "symbolic" threshold impressed on the cortex can be represented by the synchronised action of the fluxes. The differential resolution of the ear, which varies with frequency, will depend on the two differences of phase.

1610 OBSERVATIONS OF PERSISTENCE OF POST-STIMULUS MASKING. P.Dubout.

Acustica (Internat.), Vol. 9, No. 5, 353-8 (1959).

A direct experiment was used to find for three subjects the thresholds of perception of relatively faint sounds that continue steadily after a previous prolonged sound, louder but of the same spectrum, ceases abruptly. A second experiment investigated the perceptibility of discontinuity in step-wise reverberation decays as a function of the height and repetition interval of the steps. Data from both experiments are consistent with one another and with data on persistent masking inferred from earlier echo-perception experiments.

1611 THE LIMITS OF AUDIBILITY FOR FREQUENCY AND TONE NUMBER VARIATIONS IN SOUND PULSES.

R.Oetinger.
Acustica (Internat.), Vol. 9, No. 6, 430-4 (1959). In German.

The just audible frequency differences between successive sound pulses was measured in relation to the duration of the pulse. Pulses with Gaussian and trapezi form envelopes were used. The measurements were made for frequencies of 250, 1000 and 4000 c/s at a constant level of 60 dB. From the measurements the just audible change in tone number is calculated and found to be practically independent of tone frequency.

1612 MEASUREMENT OF PERSTIMULATORY AUDITORY ADAPTATION. H.N.Wright.

J. Acoust. Soc. Amer., Vol. 32, No. 12, 1558-67 (Dec., 1960).

The most frequently used estimate of perstimulatory auditory adaptation to a tone sustained in one (experimental) ear has been the intensity decrease at the contralateral (control) ear required for median-plane localization during successive 15 sec comparison intervals. Use of such a measure assumes that only negligible adaptation occurs in the control ear during these 15 sec. The results of this investigation show this assumption to be untenable. Adaptation in the control ear was measured by maintaining the experimental ear in an adapted state and then sustaining the comparison stimulus in the control ear. As the control ear adapted, the phantom sound associated with the tones to both ears moved toward the median plane. The time for this moving phantom sound to reach the median plane varied with the intensity and frequency of the comparison stimulus. The extent and rate of adaptation in the control ear was found to be such that all estimates of adaptation to tones sustained in the experimental ear are specific to the procedures used.

1613 PSYCHO-ACOUSTICS, APPLIED AND MISAPPLIED.

H.Burris-Meyer and V.Mallory.
J. Acoust. Soc. Amer., Vol. 32, No. 12, 1568-74 (Dec., 1960).

A historical survey of the attempted application of psycho-acoustic phenomena during and immediately after World War II.

1614 SCALING OF PITCH INTERVALS.

J.D.Harris.
J. Acoust. Soc. Amer., Vol. 32, No. 12, 1575-81 (Dec., 1960).

A literature review showed that in bisecting a musical interval, Ss tend to yield the arithmetic mean if the interval is large, but the geometric mean if the interval is small. Since fractionation judgments ("half-pitch") from which pitch scales may be derived would typically utilize quite wide intervals, and thereby tend to yield the arithmetic mean, a major discrepancy has arisen between such pitch scales and the pitch scale of our musical heritage, which is base upon the principle of the geometric mean. A number of experiments were performed using half-pitch and bisection judgments, are several variants of the method of equal-appearing intervals. From these it was concluded that when equal-appearing interval judgments are used with a standard interval no larger than about a musical third, a reliable psychological pitch scale emerges which agrees well with the common pitch scale of the piano keyboard. However, if the standard interval is as large as a musical fifth, the pitch scale begins to tend toward that derived from fractionation.

1615 AN AIR DAMPED ARTIFICIAL MASTOID.
[illegible]

Acoust. Soc. Amer., Vol. 32, No. 12, 1582-8 (Dec., 1960).

This was constructed to simulate the mechanical impedance of a human mastoid. Viscoelastic substances [illegible] used in [illegible] mastoid designs are not employed. The instrument is [illegible]y immune to ageing effects and can be easily reproduced. [illegible] instrument is used as a laboratory standard to determine the [illegible] transmitted through the skull by bone vibrators used in cli[illegible] audiometers and bone conduction type hearing aids.

1616 POST-TETANIC POTENTIATION IN THE MIDDLE-EAR-MUSCLE ACOUSTIC REFLEX. F.B.Simmons.

Acoust. Soc. Amer., Vol. 32, No. 12, 1589-91 (Dec., 1960).

Temporary improvement in the threshold of the middle-ear-[illegible]scle reflex in response to sound occurs following short expo[illegible]res to moderately loud sound (80-90 dB). Pre- and postexposure [illegible]flex thresholds for several frequencies were obtained from awake [illegible]ts with permanently implanted electrodes in the tensor tympani [illegible]d stapedius muscles, and on the round window. The increased [illegible]reshold sensitivity observed (up to 40 dB) is considered to be [illegible]ssifiable as a phenomenon of post-tetanic potentiation, and as a [illegible]monstration of hyperexcitability in certain brain-stem auditory [illegible]ructures following sound stimulation.

ACOUSTIC CONDITIONS ACCEPTED BY LISTENERS IN AN [illegible]UDITORIUM. See Abstr. 217

ision

612.8

1617 THE INFLUENCE ON VISUAL ACUITY OF SLIGHT VARIATIONS IN THE POWER OF THE EYE OR OF THE [illegible]RRECTING GLASSES. A.Arnulf, O.Dupuy and F.Flamant.

Opt. (France), Vol. 38, No. 5, 241-52 (May, 1959). In French.

The change in visual acuity is studied in terms of the power of [illegible] correcting glasses placed before the eye. Consideration is given [illegible] to those powers for which the eye is near emmetropia and in [illegible]pia. From experimental data, tolerances are derived for the [illegible]ers of correcting lenses in terms of the difference between the [illegible] power and the actual power that would restore emmetropia. [illegible] methods used in diurnal vision are: the Foucault test, the disk [illegible] the line test object, all dark upon a bright background. Toler[illegible]s are reduced when substituting the Foucault test for a disk or [illegible] test object. They are significantly greater than the minimum [illegible]ation (0.125 δ) of spectacle glasses when the eye is very slightly [illegible]-sighted (≤ 0.125 δ). But they become more severe as soon as [illegible]eye is made even slightly short-sighted.

612.8

1618 J_0 STIMULUS PATTERNS FOR VISUAL RESEARCH. D.H.Kelly.

pt. Soc. Amer., Vol. 50, No. 11, 1115-16 (Nov., 1960).

The advantages of spatially and temporally sinusoidal patterns [illegible] visual research are pointed out. R.A.Weale

1619 A STUDY OF TROXLER'S EFFECT. F.J.J.Clarke.

ca Acta (Internat.), Vol. 7, No. 3, 219-36 (July, 1960).

An adaptometer is described which has been built to investigate [illegible] adaption in the extra-foveal retina (Troxler's Effect). The [illegible]ment provides extra-foveal stimuli of substense up to 12° [illegible] A, and observations involve the continuous adjust[illegible] of the [illegible] of a foveal comparison field to maintain equality of [illegible] brightness. The time course of local adaptation can be auto[illegible] recorded, and has been measured for test stimuli at a fixed [illegible] of initial subjective brightness with variation of area and eccen[illegible]. Subsidiary experiments have been performed with a grating, [illegible] with pre-adaptation and with reversed contrast. Troxler's Effect [illegible] inductive process of neutralization of boundaries of contrast [illegible] the results better than the hypothesis that local adaptation [illegible] "area" effect.

1620 COLOUR CONFUSION PRODUCED BY VOLUNTARY FIXATION. K.J.McCree.

Optica Acta (Internat.), Vol. 7, No. 3, 261-90 (July, 1960).

When an observer stares at a colour-matching field he may lose a great deal of his colour discrimination. Some find it possible to match any pair of spectral colours. Prolonged staring is not necessary, but the colours must be exactly matched in brightness. A systematic study of the fixation effects indicates that they are not due to a photochemical bleaching of pigments, but rather to the reduction of eye movements. Blue—green discrimination is affected more than yellow—red.

1621 COLOR PHENOMENA.
N.Pastore.

Science (USA), Vol. 132, 1396-7 (Nov. 11, 1960).

A procedure is described which leads to reports of hues for two black figures, one of which is shadowed. Typically, the shadowed figure is seen as blue, the other as black.

1622 NETWORKS FOR PATTERN PERCEPTION.
P.H.Greene.

Proc. Nat. Electronics Conf. (USA), Vol. 15, 357-69 (1959).

This paper aims to show how a certain type of artificial network could exhibit many of the pattern-stabilizing and perceiving abilities that make human vision meaningful. The model is not intended to do entire job of pattern recognition; rather, its purpose is to "notice" and hold together good Gestalten, or perceptual units, in order that a pattern recognizer incorporating the network would have stable and meaningful units with which to operate. The model identifies perceptual units with modes of oscillation of a network of oscillators. The perceptual abilities of greatest interest are made to appear by specializing this model in such a way that it obeys certain of the equations of quantum mechanics. The motivation for this springs from the observations that many properties of quantum mechanical systems resemble perceptual phenomena, and that these properties do not depend upon particular physical details, but only upon the most general mathematical structure of the transformation formalism of quantum mechanics, which leads to theorems specifying behaviour depending upon relational aspects of complex configurations.

OPTICAL ILLUSION AFFECTING INSTRUMENT CROSS-WIRES. See Abstr. 19382 of 1960.

TECHNIQUE . MATERIALS

1623 INSTRUMENT FOR RECORDING THE DUST NUISANCE EMITTED BY CHIMNEYS.

P.A.E.Cross, D.H.Lucas and W.L.Snowsill.
J. sci. Instrum. (GB), Vol. 38, No. 1, 12-17 (Jan., 1961).

A new type of instrument has been designed to measure and record the likelihood of dust emitted from a chimney causing nuisance at ground level. The instrument measures the difference between the optical obscuration produced by a clean glass surface and that produced by the same glass surface when dust collected from a flue duct has settled on it. The method of collection is based on the assumption that vertical surfaces are more important in pollution than horizontal surfaces, and that coarse particles are more likely to cause nuisance than fire particles. Care has been taken in the design to eliminate errors normally associated with optical instruments of this nature, for example those caused by a dirty optical system, ageing photocells and lamps, and mains voltage and temperature fluctuations. The instrument has a novel recording method which enables it to operate over an unusually large range of signal levels. It will facilitate the control of dust emission from industrial chimneys.

1624 ON SOME LABORATORY APPLICATIONS OF PROGRESSIVE CHEMICAL MACHINING.

M.Odier.
J. Phys. Radium (France), Vol. 20, Suppl. No. 7, 94A-96A (July, 1959). In French.

Using the method known as "progressive chemical machining" a comparatively simple apparatus may be adapted to machine (a) samples which would require elaborate machine tools if done by standard mechanical techniques, (b) samples of such awkward dimensions or geometry that tools could not be used. A typical experimental layout and some applications are described.

G.I.W.Llewelyn

1625 SPARK-HARDENING OF METALS.

N.C.Welsh.
J. Inst. Metals, (GB), Vol. 88, Pt 3, 103-11 (Nov., 1959).

The influence of electric sparks on the structure and hardness of metal surfaces has been studied, a vibrating electrode being used to generate the sparks. Each spark fuses a small volume of metal, which rapidly chills when the discharge ceases. Steel surfaces are hardened by the thermal cycling, but evidence is given that elements derived from the sparking medium accentuate the hardness change. Thus, nitrogen from the atmosphere or carbon from an oil promote hardening even in pure iron. The same elements confer great hardness on metals such as titanium and zirconium, which react chemically to form hard compounds. Surface alloying also occurs by the transfer of matter between the sparking contacts, and experiments with sintered-carbide electrodes show that very hard, wear-resistance layers can be formed on most engineering metals. Spark treatment has been successfully developed in Russia as a practical process for hard-surfacing steel, and wear tests carried out in the present work indicate its potential value in the non-ferrous metals field.

1626 FURNACE FOR THE UNIFORM HEATING AND MIXING OF POWDERS IN CONTROLLED ATMOSPHERES.

H.Monk and F.F.Kierys.
J. sci. Instrum. (GB), Vol. 38, No. 10, 397-8 (Oct., 1960).

An experimental furnace for calcining powders in the temperature range 700°-1000° C is described. A cylindrical tube is used as the furnace "body", and rotation about an axis perpendicular to the axis of the cylinder gives, by a tumbling action, satisfactory mixing provided the ratio of diameter to length is not too small.

E.G.Knowles

1627 CONICAL BASKET HEATER FOR HIGH TEMPERATUR EVAPORATIONS OF METALS AND OXIDES.

J.T.Krau
Rev. sci. Instrum. (USA), Vol. 31, No. 8, 907-8 (Aug., 1960).

A conical basket is made by winding 0.020 in. W wire into the desired shape. Current is conducted to the rim and to the apex of the basket and, by spring pressure, these leads short-circuit the individual turns.

A.H.W.Bec

ERRATA

Abstr. 5618 (1960) line 4: for "Chzou Guan-Chzao" read "Chzhou Guan-Chzhao".
Abstr. 6036, 6597, 6611, 19379 (1960), journal reference: for "math.-phys. Kl.IIa" read "II. math.-phys. Kl."
Abstr. 14414-16 (1960) line 1: for "CHARTS OF THE BALANCE" read "DEVIATIONS FROM EQUILIBRIUM".
Abstr. 18096 (1960) line 7: for "(Fi_2O_3)" read "(Fe_2O_3)"
Abstr. 18741 (1960) line 2: for "M.Schwarzchild" read "M.Schwarzschild"
Abstr. 18922 (1960) line 10: for "200 m" read "2000 m".
Abstr. 19188 (1960) line 3: for "K.Chul-Soo" read "C.S.Kim".
Abstr. 19957 (1960) line 4: for "Abstr. 2308" read "Abstr. 2308 of 1956".
Abstr. 21341 (1960) line 2: for "I" read "I(1)".
Author Index (July, 1960): insert "Glashow,S.L., 9333"
(Oct., 1960): for "Kafman,A.N., 15022" read "Kaufman,A.N., 15022".
(Dec., 1960): after "Gadsden,M." insert "21330".

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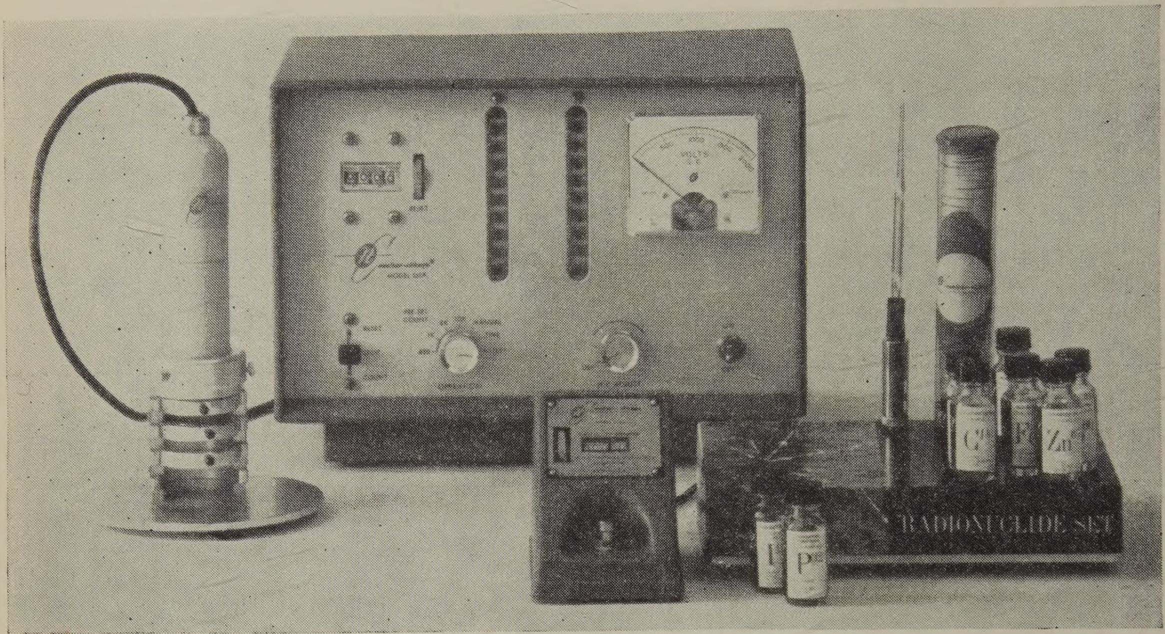

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